DATA INTERNATIONAL

A Portable Sawmill

In September, 1963, a letter was received by DATA International of Palo Alto, California from a Christian missionary to Colombia, S.A. The letter expressed need for a machine for cutting trees into boards at the site of the stump. A photograph of the letter appears as Figure 1. DATA International responded by sending information about available machinery and also by inquiring among consulting engineers for suggestions to meet the need.

DATA International

DATA (Development and Technical Assistance) is a group of 5 full-time and 25 volunteer employees with a 3,000 square foot office organized as a clearing house for engineering and technical problems from sub-industrialized countries around the world. DATA has a list of 1500 engineers, scientists, and other experts in the United States who volunteer to answer questions without charge concerning technical problems of sub-industrialized countries. The questions come to DATA through letters from farmers, missionaries, businessmen, professors, Peace Corps and government workers anywhere and are referred by DATA to the appropriate volunteer consultants for answers.

Questions answered during the past 6 years since DATA was formed have involved projects such as construction of a 50-bed hospital in Ethiopia, braces for crippled children in Nigeria, a roof for a small chapel in Korea, and a road with seven bridges in Madagascar. Chick nutrition in Uganda and bee-keeping in the Dominican Republic have been other subjects of advice, a total of about 1000 problems per year being answered on a total DATA budget of $40,000 provided by individuals and foundations.

Mr. Douglas Hayward, Projects Coordinator of DATA commented, "It is expected that consultants will pay close attention to constraints and opportunities of the specific locality they are advising. In designing a church for 100, for instance, an engineer found he was limited to a budget of $280 and use of local raw materials for construction. He designed a structure to be built of bamboo and thatch. He further provided that the structure could be built by unskilled workers, and he provided instructions intended to teach them useful knowledge of construction which they could apply in building other structures of their own. Thus he designed a building and a training program in one package. (Pictures of a model of the church appear in Figure 2.) The instructions began with how to draw a circle with a stick and string."

Prepared in the Design Division, Department of Mechanical Engineering, Stanford University, by Robert Regier under the direction of Peter Z. Bulkeley as a basis for student exercise. Support of the National Science Foundation contract number GE-3905 is gratefully acknowledged.

ECL-22
M.E.- 114b-2

c/o Mr. Herman Goff
Greenwood Hwy.
Saluda, S. Car.
Aug. 30, 1963

DATA
Palo Alto
California

Dear Friends,

I was quite interested in an article about your work which appeared in a recent copy of Christian Life (July issue I think it was). Mrs. Corwin and I have been missionaries working in Columbia under the South America Indian Mission since 1941. (The Mission address is P. O. Box 769, Lake Worth, Flrida). At present we are beginning another furlough but expect to return to Columbia next year.

I would appreciate it very much if you could send me the drawings for the washing machine which was illustrated in the above mentioned article. I believe that some of the believers in Colombia would be glad to have a local carpenter make them such washing machines. In fact I know two carpenters who are believers who could probably do the work since they are able to make first class furniture.

I would also like to solicit your help in a project which I have thought of for years but which I do not have the engineering ability or capital to develop. In the mountainous area around our former station of Atanquez there are places where good lumber could be cut. Since such places are miles from where any truck could go, the only way used at present is to cut the trees with axes or a crosscut two-man saw into logs, build a platform on the downhill side of a log, and after rolling the log onto it, saw the boards or planks by hand with a two man rip saw. Because this system is slow, lumber is not so available as it should be. For building material many people cut small trees of the best kind available - trees from three of four inches in diameter up to perhaps eight inches in diameter, using these for rafters, ceiling joists etc. instead of sawed lumber. The result is that future good lumber trees are disappearing while larger trees which would yield much more lumber are being utilized much too little.

I am not interested in any such systems as were used for instance in virgin forests of western United States for collecting logs at a saw mill. I do not think it would be practical even if one had large quantities of money to put into it. What I have in mind is some type of portable power saw which could cut boards from a log where it lies when felled. Of course some adjustment of a log with cant hooks would be no problem but setting up a carriage which would carry the log back and forth in front of a circular or band saw would I think, involve altogether too much transporation of heavy equipment from one tree to another in places where everything ought to be reduced to less than one hundred pound pieces which a man could carry on his shoulder in steep places where paths may be lacking.

Figure 1

I had thought of this. Two rails which could be clamped on to the two sides of the log to be sawed. On these rails would ride a small carriage carrying a band saw operating, not vertically as band saws usually operate, but horizontally. When the required length of slab or board had been cut, the carriage could be backed up and either a two man cross cut saw or a power chain saw used to cut off the board. After removing the slab or board the two rails could be readjusted to rip the next board. The bottom half, third or fourth of the log could be left until the first slab (or perhaps more) had been removed from the next length on the same tree. Then that leftover piece could be cut off and turned flat side down on the surface just exposed by the removal of a slab. With proper adjustment of the side rails this left-over piece could be sawed into boards and a slab before proceeding to saw the log on which it rests.

In some cases it might be necessary to cut the fallen tree into log lengths before beginning the sawing, but in others it might be better to leave the fallen tree undivided until each board was ready to be cross-cut after it had already been rip cut. That way the branches at the top of the tree could help to steady the log and make it less liable to roll.

All this is only an idea I have had in my head along with a few rough drawings. I don't know if a band saw can be made to work horizontally. I realize of course that it would be necessary to slide in slats behind the saw to keep the weight of the board from causing trouble. Proper precautions would have to be made to be sure the log did not roll while the saw was working. The motor could not be too heavy. Perhaps the motor could be disconnected from the saw and carriage for carrying from one location to another in a separate load.

It is quite possible that some entirely different plan could be devised to get satisfactory results under these conditions.

Perhaps I had better mention that the lumber sawed in these places is carried to foot paths and there loaded on the backs of oxen or mules or burrows.

Power chain saws are available in Colombia and one of the believers in Atanquez is considering buying one.

Another project which is perhaps much more important in this. The farmers in those mountains are obliged to cultivate their land with machetes and shovels. The result is that even on the one-family farms they sometimes have to hire help, even though the income from the farm is so limited. Larger farms are maintained by using considerable hired help which perhaps has disadvantages in the direction of peonage.

I have given some thought to a power tool which could be carried on a man's back and used for cutting grass, weeds, small underbrush close to the ground, on the steep hillsides where many of these farms are located. I had thought of a mowing machine scissor type cutter activated by a flexible cable running through a flexible tube from the motor on the man's back, possibly with a free piston rather than a fly wheel. It would be important to cut down vibration which would probably be quite tiring when used all day long. Small stones could cause trouble. It would be necessary to reach alongside of and between larger stones or rocks perhaps. Perhaps vibration could be cut down by opposing simultaneous explosions in the motor being used to simultaneously move opposite sets of blades in opposite directions in the cutting arm. I know of course that the cutting arm would have to be much shorter than in a regular moving machine.

If a sturdy machine which could do good work rapidly could be developed I should think that it would be of great benefit to these farmers.

1. They could increase the size of their farms to some extent and thereby have a little better income.
2. Perhaps the mulch of the frequently cut undergrowth around corn, yuca, cane, etc. would enrich the ground and yet the undisturbed roots of that undergrowth would protect the soil from the heavy erosion which they now have for the rains in these mountains are heavy.
3. Pasture lands have been burned off frequently to the impoverishment of their soil. If such a machine could be used to cut down the old grass soon after the rainy season begins the new growth would be, I should think, as attractive to cattle as the new grass that comes up after the pasture has been burned off, and of course the old cut grass would, in the rainy season, rot and fertilize the soil.

I suppose it would be necessary to take some precaution against carbon monoxide poisoning with a machine on a man's back.

In the town of Atanquez there is good-sized evangelical church, and as a result, an evangelical school where children of believers can be educated. Although they are hardworking people, their income is so limited that some do not feel they can give their children more than the first two or three grades of school. Yet from these children from evangelical homes should, with proper education, come teachers and national christian leaders, well prepared national pastors etc.

The Mission subsidizes the school and as we are able we plan to help some more promising individuals go on to a more complete education, as we have already done in a few cases, but if they themselves had the income to finance these things it would be much better I should think. As it is they support their own national pastor and have enlarged their chapel at their own expence.

I regret that these ideas I have presented have not been tried out and so it could be that they are impractical. But you will know people who could wisely judge their value and who can perhaps suggest a much better solution.

I believe you are in an important work - a work which contributes indirectly but practically to carrying forward the Gospel of our Saviour to others who have not yet heard it.

Yours in His faithfulness,

Orland H. Corwin

Figure 1 (cont.)

Figure 2 - A Model of a Church In Ghana Courtesy of DATA

Letter from a Missionary

The letter of Figure 1 was received as one of the 3 letters per average day coming to DATA. As usual, DATA responded with such information it had on available products possibly suited to the need. Illustrations of such products appear in Figures 3 and 4. Thinking consultants might be able to suggest answers clcser to the need than products currently on the market, DATA decided to solicit their advice as well. The customary procedure at DATA is to contact at least three consultants at a time, for benefit of independent opinions. If the consultants offer sharply conflicting solutions, the reasons for disagreement are investigated by DATA. After such inconsistencies are resolved DATA forwards a consensus of consultant opinion to those requesting advice.

Often engineers giving service through DATA find themselves working on problems quite new to them. Mr. Hayward believes a premium should be placed on the ability to think in terms of unfamiliar requirements when working on the sorts of problems DATA receives. An electronics engineer from an aerospace company who volunteers might find himself working on design of an adobe plumbing system, since problems of aerospace electronics are hardly to be expected from sub-industrialized countries.

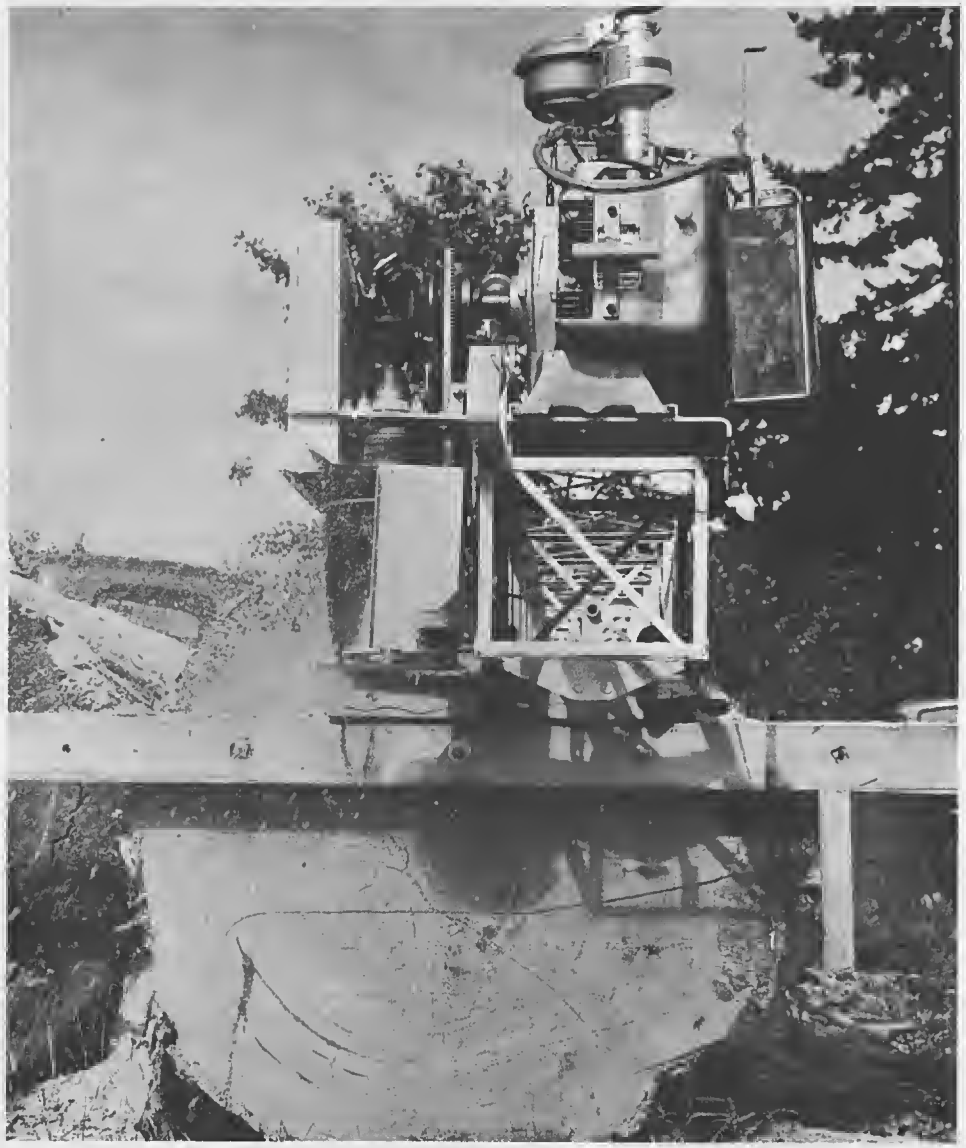
He might also find it necessary to acquaint himself for the first time with aspects of the lumber industry in order to respond to an inquiry such as that of the missionary's letter in Figure 1. The discussion which follows is intended to present some information useful as background to the missionary's request.

EARLY SAWING METHODS

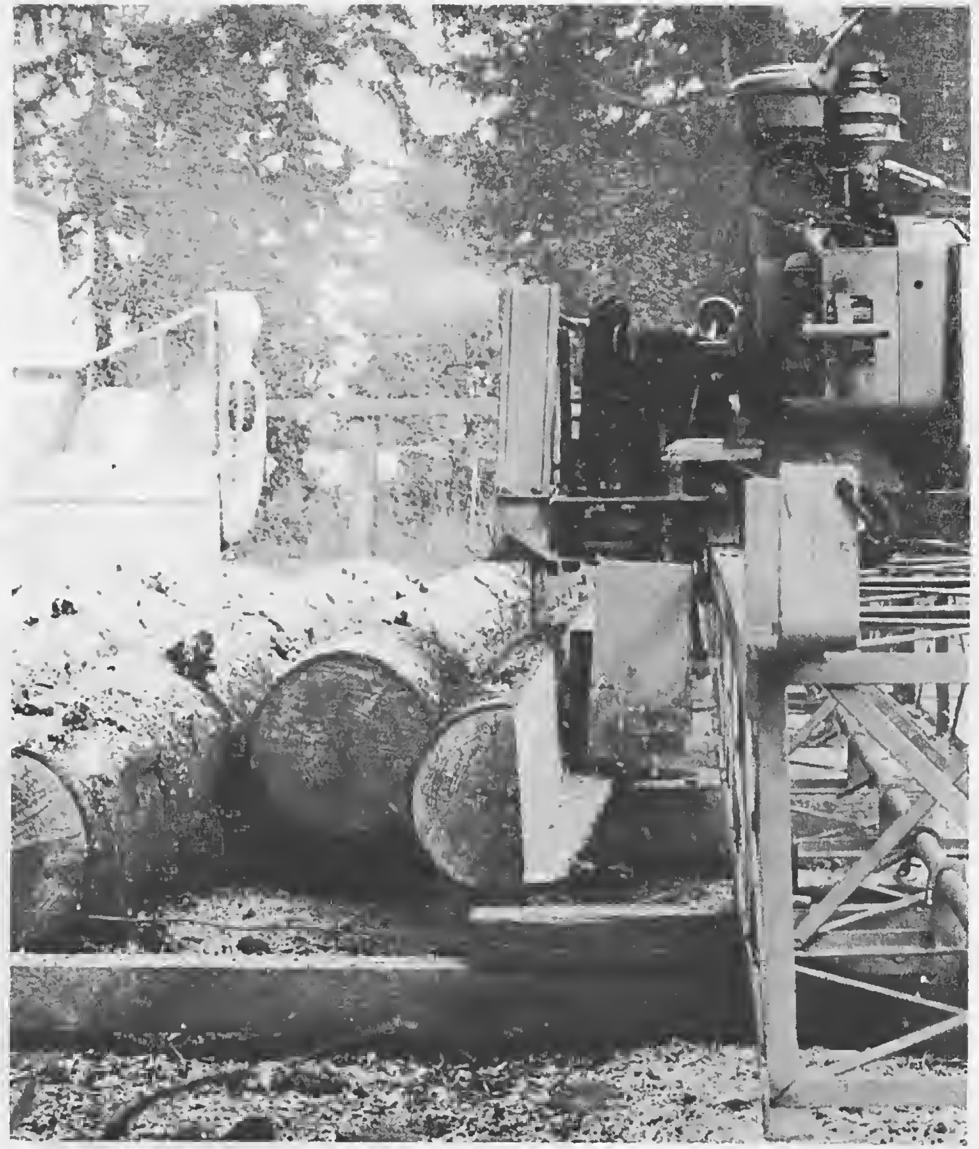
Crosscut saws and axes have long been used in the American lumber industry to fell trees; however, modern felling practice uses chain saws almost exclusively. A classic example of a 12-foot diameter cedar tree being felled in 1906 near Olympia, Washington appears in Figure 5. The fellers work while standing on springboards, as shown, which are wedged tightly in the bark.

One of the earliest devices used to convert logs into boards was the whip or pit saw. A typical version of this two-man hand saw is shown in Figure 6. It is being used in the Near East to convert squared logs into planks. The pit saw is rarely used in technically advanced countries, but it is still common in many industrially underdeveloped countries. During saw operation the log is supported on a platform or over a pit to permit one sawyer to work from the upper side and one from underneath. The man underneath performs the cutting operation on the down stroke, and the man above returns the saw for the next stroke. Sometimes sawing is converted to a one-man operation by utilizing a spring which returns the saw for the next stroke. According to Bryant,[1] "a day's work for two men is from one hundred to two hundred board feet of planks or boards".

1. R.C. Bryant, Lumber, 2nd ed., John Wiley and Sons, New York, 1938.



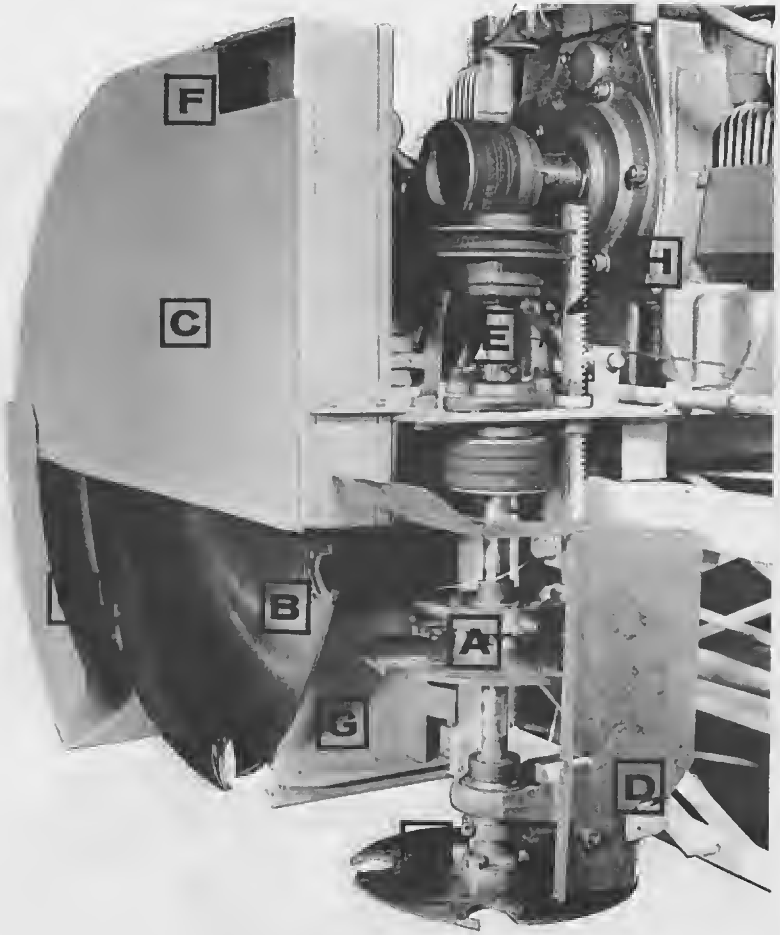
Large Log Operation



Small Log Operation

Figure 3 - TIMBER CHAMP Sawmill

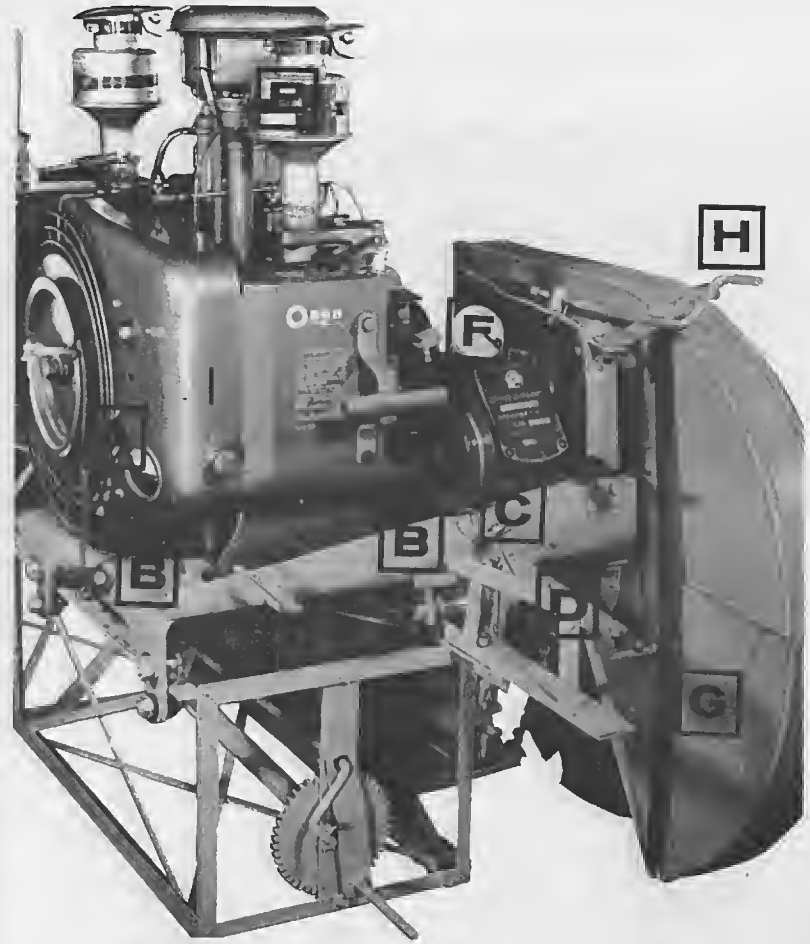
Courtesy of H.H.C. Research
and Development Corp.



CARRIAGE, ENGINE AND SAWS

are shown in this view. Note insert saw teeth on circular main saw, as well as on both edger saws. Parts are identified by letter.

A—Edger saws
B—Main arbor saw
C—Main saw guard
D—Edger saw guard
E—Edger drive shaft
F—Sawdust exhaust
G—Lumber return gate
H—Adjustable top edger shaft



CONTROLS AND MAJOR COMPONENTS

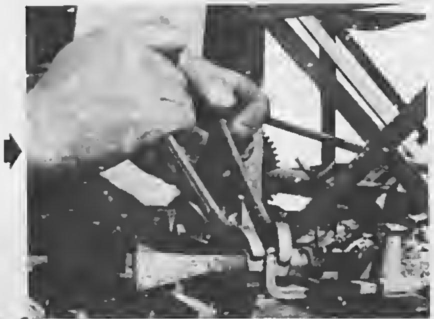
of unit appear in this view, as seen from the operator's position. Simplicity of design enables saw to function efficiently, even on steep terrain.

A—Engine starter
B—Carriage assembly
C—Cable drive pulley
D—Cable tension adjustment
E—Spark arrester
F—Edger saw adjuster
G—Main saw guard
H—Carriage speed-control

Figure 3 (cont.) - TIMBER CHAMP

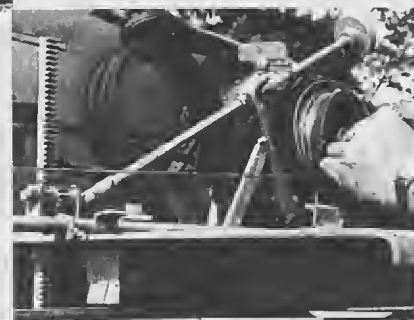
Courtesy of H.H.C. Research and Development Corp.

Bridge-braced carriage track is strong and rigid, yet light enough to be carried easily by one man.



Feeler gauge is easily adjusted to obtain any desired thickness of lumber up to maximum of 2¼". Once set, gauge will hold adjustment with no further attention.

Two sections of track, each 10 feet long, are bolted together as first step in setting up saw for on-site sawing.

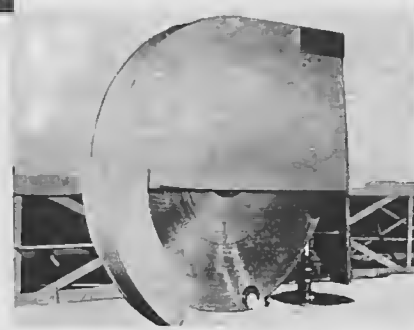


Heart of carriage drive mechanism is this simple pulley and cable arrangement. Pulley and single lever at end of track control all movements of carriage.

After tracks are bolted together, one end is placed on 4x4 runner and secured. Process is repeated for other end. One man does entire task.

When sawing large logs, two measurements at each end of log assure maximum accuracy for placement of saw for next series of passes. Move can be made in short time.

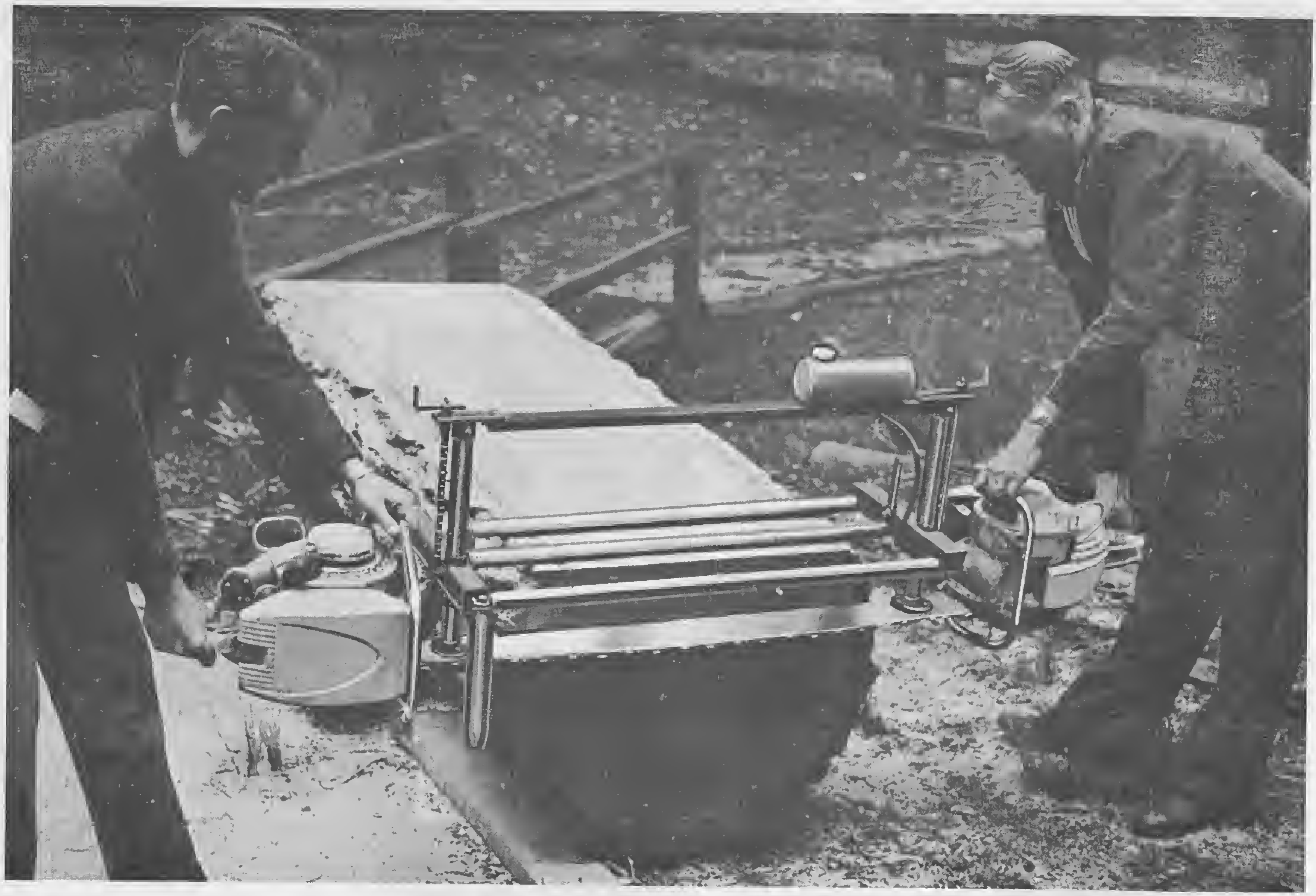
Carriage is being placed on track in this view. Alternative method is to place carriage and engine on track while track is on ground, then lift alternate ends to 4x4.



Saw guard is shown in extended position as saw returns to operator, protecting sawyer while he makes rapid adjustments for next cut.

Figure 3 (cont.).- TIMBER CHAMP

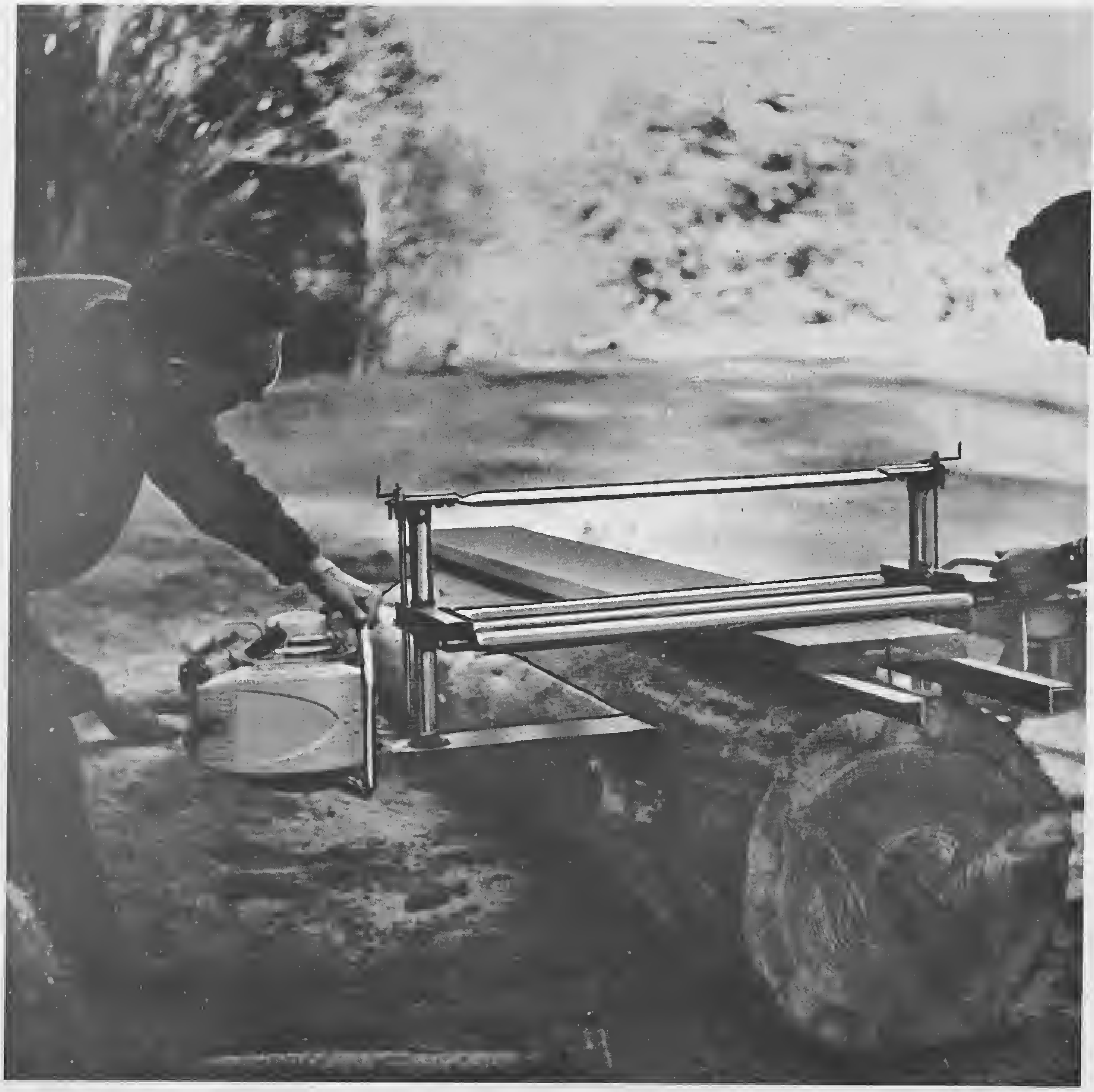
Courtesy of H.H.D. Research and Development Corp.



Sawing Large Planks

Figure 4 - The ALASKAN

Courtesy of Nygran Industries



Making the First Cut

Courtesy of Nygran Industries

Figure 4 (cont.) - The ALASKAN

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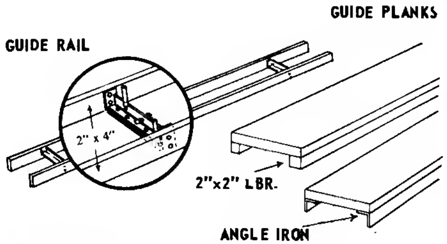
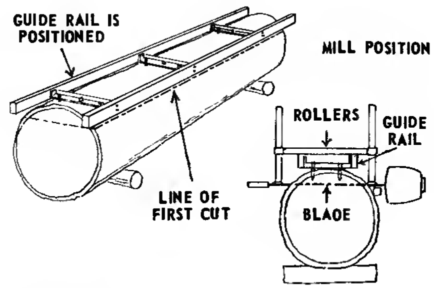
HOW TO MAKE LUMBER WITH THE ALASKAN JR. CHAINSAW MILL



PREPARING GUIDE RAIL OR GUIDE PLANK

An occurate dependoble guide system is absolutely necessary before attempting to operate your "ALASKAN JUNIOR". Nygran Industries has perfected a steel spreader-bracket, with anchoring pegs, which when spaced and bolted in position every four to five feet between two straight 2"x4"s make the ideal guide rail for your chainsaw mill. If you have not as yet obtained these brackets, a guide moy be fashioned from a good straight 2"x12" plank with 2"x2"s or angle irons securely fastened to the plank edges to form a saddle rest when plank is placed on the log in preparation for the first cut.

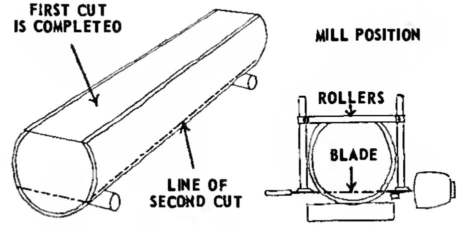
1



SETTING UP FDR TNE FIRST CUT

Place the guide rail (centered) on the log and secure. The guide rail must project at least six inches beyond the ends of the log so that the saw will leave the cut level and evenly. This basic or first cut determines the accuracy of oll later cuts, so make sure it will be true and level and that the greatest amount of lumber will be produced from the log.

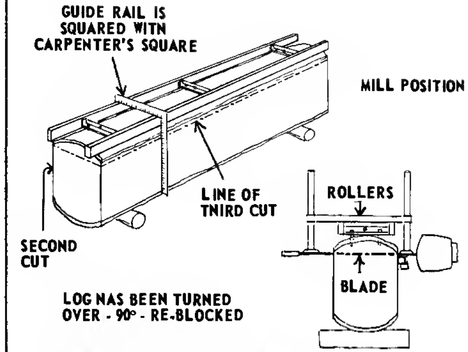
2



MAKING READY FOR TNE SECOND CUT

Remove the guide rail ond slab os the mill rollers will now ride on the level surface of the first cut while making the parallel second cut. Lower the Blade, using the thickness gauge to the lumber dimension desired. If, for instance, you are planning to make planking—the slab to be taken from the bottom of the log will be approximately the same size as the slab from the first cut. Wedge this cut open to prevent the saw bar from pinching.

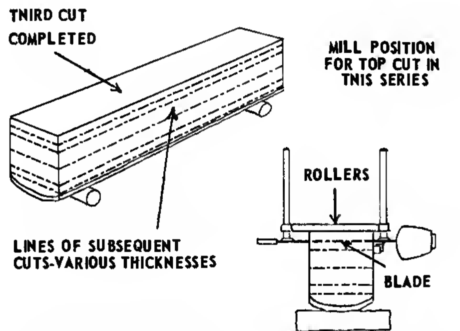
3



PREPARING TO MAKE TNE THIRD CUT

Now rotate the log 90° and brace the log firmly. Replace and fasten the guide rail. Be sure to use a corpenter's square to insure that the third slabbing cut will be at right angles to the faces of the first and second cuts.

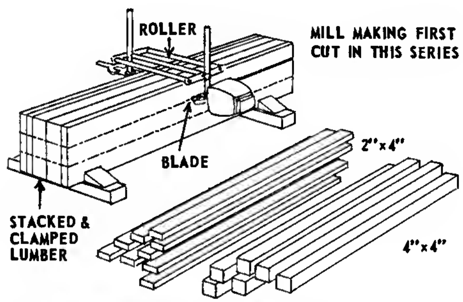
4



REAOY TO CONVERT CANT INTO LUMBER

You are now ready to convert the cont into lumber. Remove the slab and guide rail. Determine the thickness of the planks or boards to be produced and set the gauge to the correct thickness. Remember that the mill rollers ride on the level surface of each previous cut so take care that the saw enters and leaves the cut evenly.

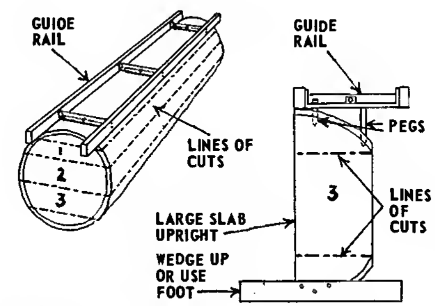
5



MAKING DIMENSION LUMBER FROM SAWN PLANKS

When you desire to make dimension lumber; gather the sow planks as shown and clamp firmly. Now adjust the thickness gauge as required so as to cut 2"x2"s, 2"x6"s or 2"x12"s as an exomple. Keep in mind that if various sizes ore plonned to be taken from the same log, such as 4"x4"s, 6"x6"s, 4"x8"s, etc., the various dimensions needed must be allowed for when making the previous cuts. See Step Five.

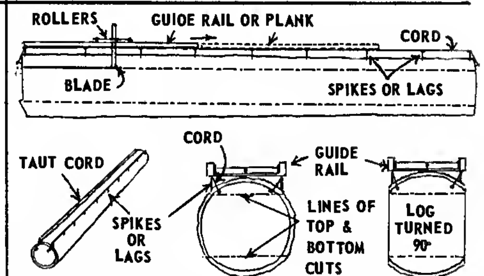
6



TIMBERS—CANTS—BEAMS—ETC., FROM LARGE LOGS

To split larger logs into two or more sections, proceed os in Step Two. The sizes of these heavy pieces are controlled by the setting of the thickness gauge. The guide roil is used in the some monner os previously described (Step Two). The cuts will require wedging open due to heavy weight.

7

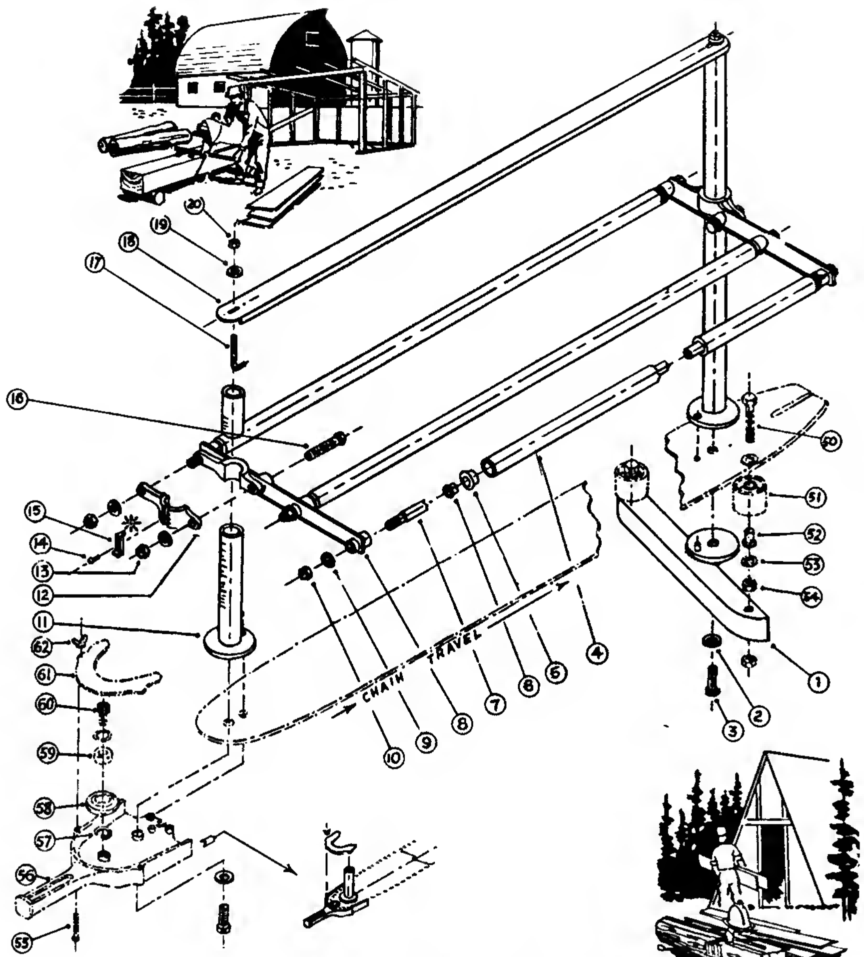


STEPS TAKEN IN THE MAKING OF PREMIUM LENGTN BEAMS

When cutting extra long or premium beoms, use two guide rails or planks for the initial cut. Before placing the guide rails, stretch a heavy cord from one end of the log to the other. Drive spikes or lags to the height of the cord as a means of keeping the guide rails true and level. When the mill has passed beyond the first guide rail, remove the guide rail. Proceed in this step and repeat process for the entire length of the log. When using one guide rail, raise the mill and slide the guide rail ahead along the heads of the lags or spikes.

8

Figure 4 (cont.) - The ALASKAN   Courtesy of Nygran Industries



ASSEMBLY INSTRUCTIONS

STEP 1 Prepare holes in your saw bar using template supplied, (See drilling instructions).

STEP 2 Loosen part No. 8 on both sides and insert riser posts No. 11 with the calibrations to the outside.

STEP 3 Next, using bolt No. 3, fasten riser post flange No. 11 to top surface of saw bar while holding thrust roller assembly in position on lower surface of saw bar – (Do not tighten). Now fasten the other riser post.

STEP 4 Now lower roller assembly to 1" mark on riser posts checking to see that it moves freely. Then securely tighten riser post flanges to saw bar.

STEP 5 Raise roller assembly to the 12" mark on riser posts and fasten tie bar No. 18 with parts No. 17, No. 19 and No. 20.

STEP 6 Readjust indicator No. 15 to riser post calibrations if necessary.

PARTS LIST

Ref. No.	Part No.	Qty.	Description
1	761	1	Thrust Roller Bar
2	659	2	Washer, Plain 3/8"
3	762	2	Bolt, Machine 3/8" Hex Hd.
4	763-1	3	Roller, Horiz for 2D-755
	763-2		Roller, Horiz for 2D-756
	763-3		Roller, Horiz for 2D-757
5	841	6	Bushing, Roller End
6	847	6	Bushing, Nyliner Type 6, $\frac{1}{2}$"
7	764-1	3	Shaft, Horiz. for 2D-755
	764-2		Shaft, Horiz. for 2D-756
	764-3		Shaft, Horiz. for 2D-757
8	843	2	Thickness Gage Bracket
9	660	6	Washer, Lock 3/8"
10	686	6	Nut, Shake Proof, 3/8 - 16 Thd.
11	779-12	2	Riser Post 12"
	779-18		Riser Post 18"
12	860	2	Thickness Gage Bracket Cap
13	857	2	Nut, Hex Hd. 5/16 - 18 Thd.
14	845	2	Screw, Binding Head, 6-32x$\frac{1}{4}$" Lg.
15	844	2	Indicator
16	765	2	Cap Screw, Hex Hd. 5/16-18 Thd. 1-3/4" Lg.
17	766	2	Bolt, L Shaped, $\frac{1}{4}$ - 20 Thd.
18	777-1	1	Tie Bar for 2D-755
	777-2		Tie Bar for 2D-756
	777-3		Tie Bar for 2D-757
19	667	2	Washer, Plain $\frac{1}{4}$"
20	688	2	Nut, Shake Proof $\frac{1}{4}$-20 Thd.
			Handle with roller..(COMPLETE)..Model 4C975
50	780	2	Cap Screw, Hex Hd. 3/8-16 Thd. 1-3/4" Lg.
51	836	2	Thrust Wheel
52	837	2	Bushing, Nyliner Type 3/8"
53	659	4	Washer, Plain 3/8"
54	686	4	Nut, Shake Proof 3/8-16 Thd.
55	341	1	Screw, Round Hd. 10-24x1$\frac{1}{2}$" Lg.
56	971	1	Helper Handle
57	970	2	Lock Ring (TruArc)
			Accessories
58	968	1	Idler Roller
59	969	1	Bearing
60	973	1	Screw Allen Hd. 3/8-16x1" Lg.
61	976	1	Cover (Helper Handle)
62	27	1	Wing Nut 10-24

Figure 4 (cont.) - The ALASKAN

Courtesy of Nygran Industries

Figure 5 - Tree Fallers

D. Kinsey and R. Andrews,
This Was Logging, 1st ed.,
p 43, Superior Publishing
Co., Seattle Wash., 1954

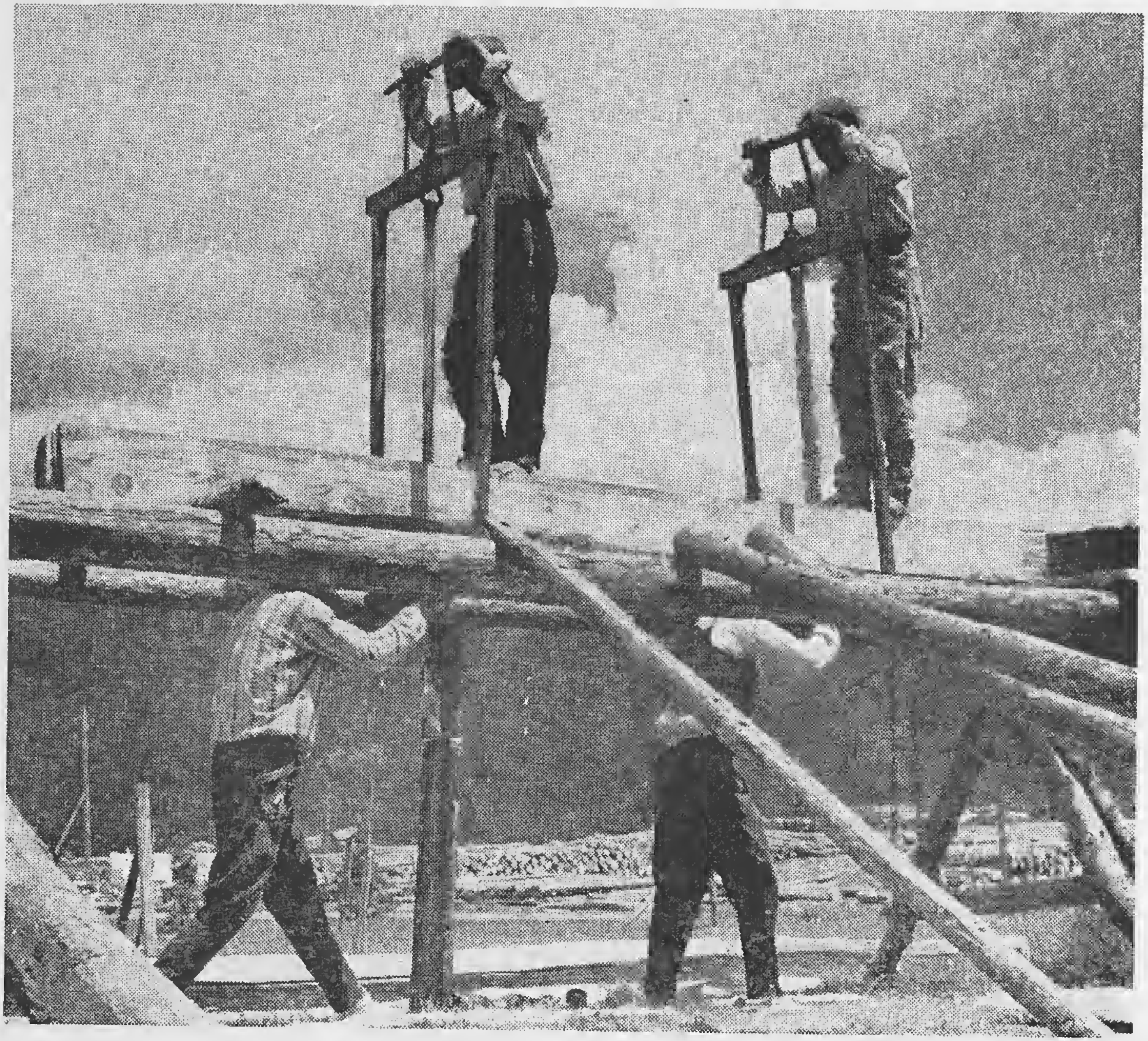


Figure 6 - Pit Saw

N. Brown and J. Bethel, Lumber, 2nd ed., p11, John Wiley & Sons, Inc., New York, 1958

The sash saw was the mechanized offspring of the pit saw. It had a single blade which traveled between side guides. The sash was moved by a water wheel crank and linkage as illustrated in Figure 7. The logs were supported by a crude carriage which was driven by a primitive ratchet feed mechanism.

The gang saw succeeded the sash saw, its most primitive form being a sash saw with several blades. During the past two hundred years, it has been continuously improved and today it is one of the most important tools in lumbering. Gang saws are the most commonly used sawing machines throughout most of Europe and have also been used to some extent in America. A typical gang saw appears in Figure 8.

Circular saws became popular with the advent of steam power in sawmills. The original circular saw was solid toothed, but subsequent improvements provided auxiliary inserted teeth which fit in sockets on the periphery of the saw plate. Figure 9 shows a typical small circular saw operation.

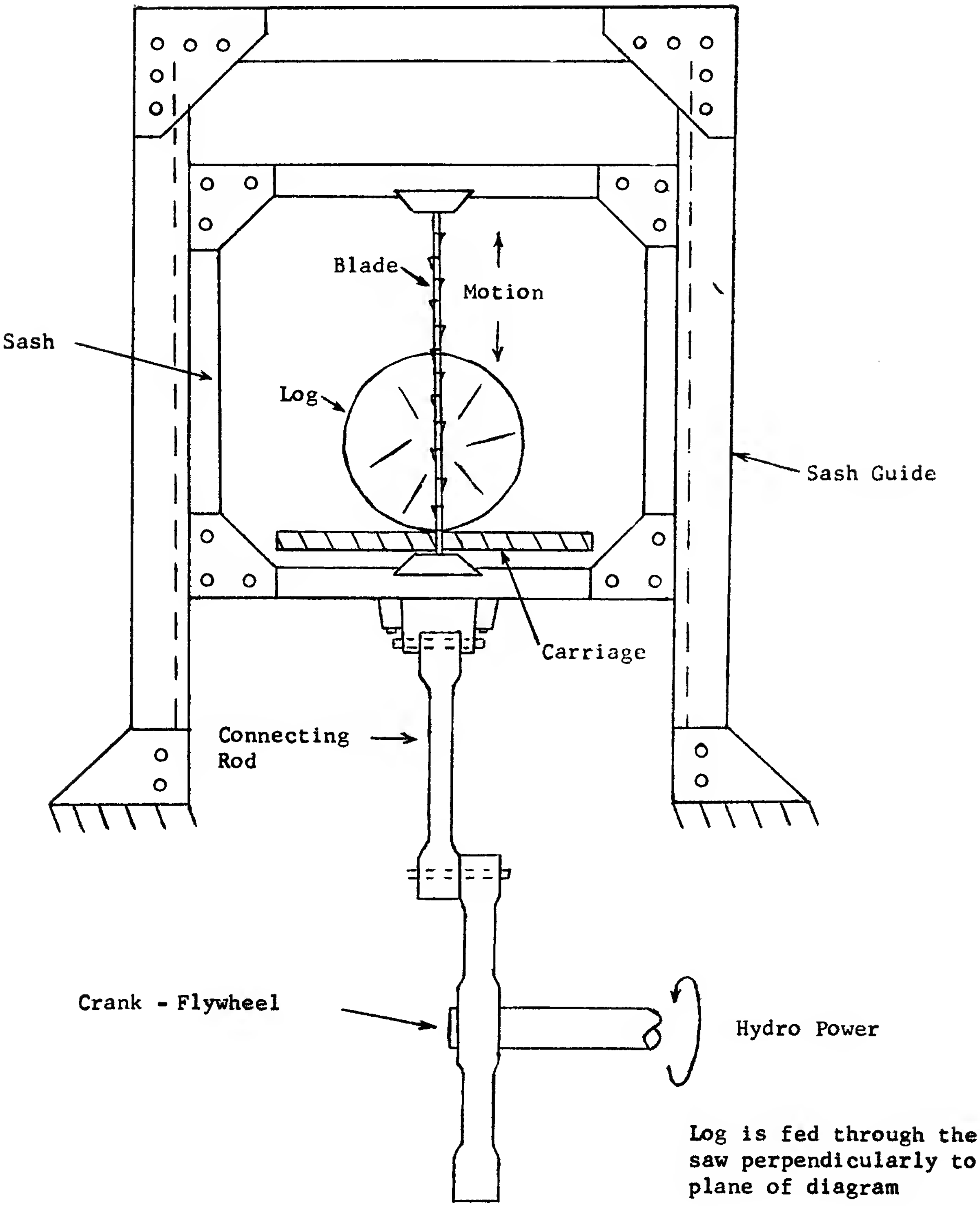
The band saw was invented in England in 1908. It has several advantages over the circular saw, including the removal of a narrower kerf* and easier adaptation to logs of a large diameter. Early band saws were difficult to maintain, but a period of technological development has brought increased reliability and the band saw has become a standard machine in large mills. Because of inherent maintenance problems in band saws (to be discussed later) smaller mills usually employ the more reliable circular saw.

U.S. SAWMILLS

American sawmills range widely in size. Large mills produce up to one million board feet per eight-hour shift; smaller units at full capacity may average as little as four thousand board feet per day. Many small sawmills owned by farmers and furniture manufacturers produce at an even lower rate with intermittent operations. Among the factors influencing sawmill size are the financial resources of its owners and the size, volume, and location of the timber resources supplying logs to the mill.

For economic reasons most sawmills are located within about 60 miles of their most distant supply of timber. Logs are normally hauled from stump to mill by truck or tractor over bulldozed trails in the woods, and from mill to retail lumber yard by truck and rail. Wet seasons in some woods make it nearly impossible to move logs over the temporary logging trails; therefore, some mills stockpile logs. The portable mill is normally taken to the logging site so logs need be moved only a small distance. A portable mill may be used when small amounts of lumber are required and the cost of transporting the logs a long distance is prohibitive. However, most portable mills are not capable of performing the wide diversity of operations, such as selective defect elimination and surfacing, which are characteristic of many large permanent sawmills. Portable mills are usually kept at a site for a period of a few weeks to several months and then moved to another location. Accordingly, the site selected for a portable mill should require

*Kerf is the width of cut removed by a saw.



Front View

Figure 7 - Schematic Drawing of a Sash Saw

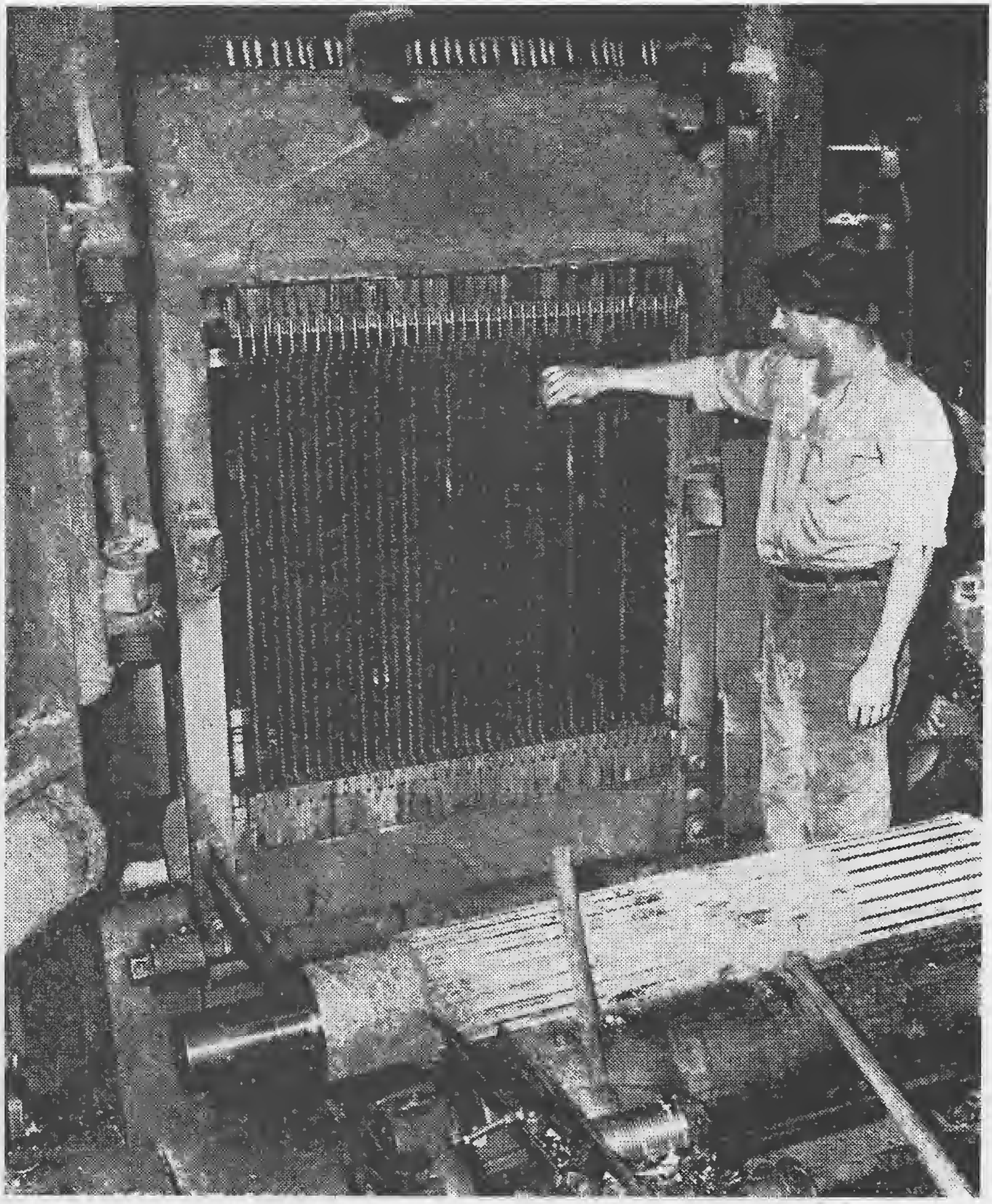


Figure 8 - Gang Saw   N. Brown and J. Bethel, Lumber, 2nd ed., p79, John Wiley & Sons, Inc., New York, 1958

Figure 9 - Circular Saw

Courtesy of The Jack Daniel Distillery Inc., Lem Motlow Prop.

the expenditure of a minimum amount of time and money in preparing it for use.

The process flow chart of a typical large permanent sawmill is shown in Figure 10. Logs are moved from their storage place, frequently a pond, to a deck where they are queued for sawing. They are then individually moved onto a carriage which moves them past a stationary saw called the head saw for the major decomposition into lumber. The resulting lumber is cut to a commercial size and freed of some defects by special purpose saws. Prior to storage, the boards are classified according to size and quality. Products from these saws as well as other sawmill waste is converted into small pieces by a "hog" for use as fuel.

By "portable sawmills" we refer to those which are easily moved to semi-permanent sites. This type of commercial mill is not to be confused with the portable saw (such as the chain saw) which is moved to each individual log at the site where it is felled. Portable mills are moved every few weeks or months as the surrounding woods are thinned. Accordingly, the layout should be such as to minimize set-up cost and at the same time provide for efficient operation. The portable sawmill normally utilizes a single power unit, which supplies power to the head saw and the edger and trimmer if the latter pieces are used. Power from the prime mover is supplied to the head saw mandrel and the auxiliary equipment is driven by the mandrel through belt transfer. Small portable sawmills are frequently laid out as in Figure 11.

SAWMILL EQUIPMENT

Jack Ladder. In large mills, a jack ladder is usually used to lift logs from a storage area to a sawmill deck. The jack ladder has a V- or U-shaped trough in which an endless chain with log hooks hauls the logs lengthwise to the deck floor of the mill.

Log Deck. A log deck located at the mill end of the jack ladder provides space for storage of logs before they reach the head saw. The log deck is usually equipped with (1) cutoff saws to cut long logs into shorter ones, (2) one or more log "kickers" (hydraulically activated arms) to push logs from the jack ladder onto the log deck, (3) a "stop and loader" to hold back logs until they are needed on the head saw carriage, and (4) a log turner or "nigger" which pushes logs from the deck onto the carriage and turns them as required by the sawyer.

Cutoff Saws. Logs are frequently brought to the mill in long lengths. This lowers yarding and holding costs and maintains an availability of long lengths for special orders of long lumber. Long logs are sawed to the required length at the mill by a circular cutoff saw. In small portable mills cutoff is usually accomplished with a portable chain saw.

Log Turners and Loaders in Small Mills. Logs are usually moved on a small sawmill deck by gravity and by hand. Workers use "cant" hooks to roll the logs from deck to carriage. The smallest portable mills usually do not use

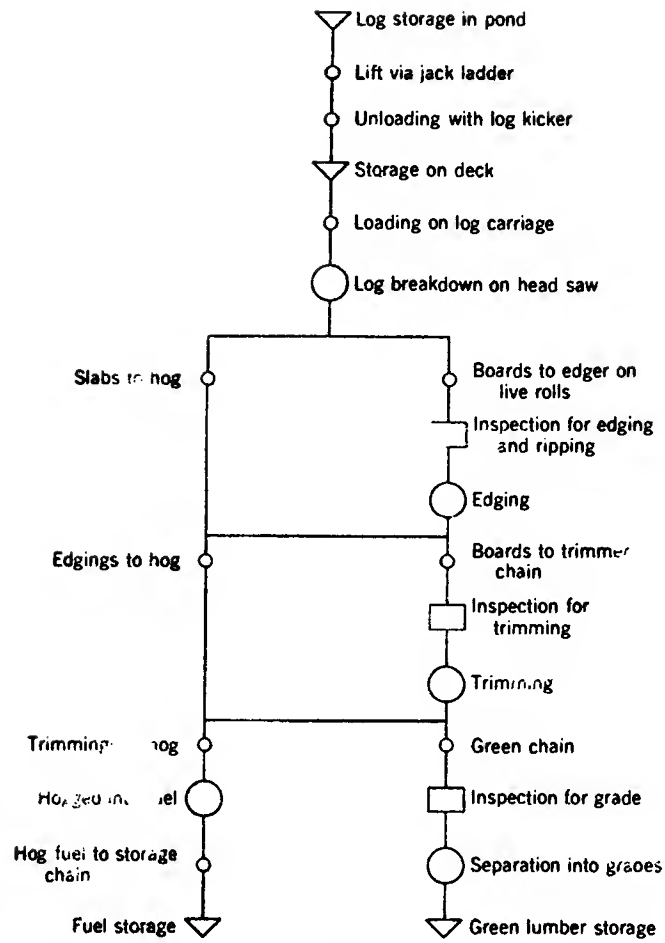


Figure 10 - Sawmill Process Chart

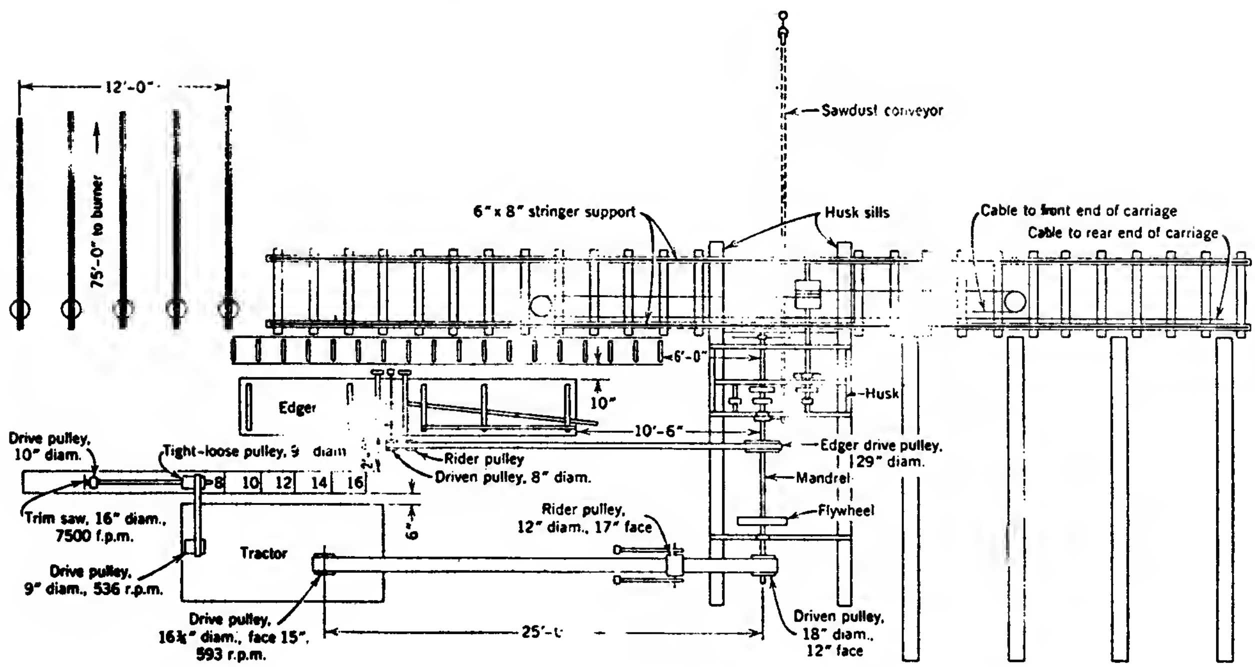


Figure 11 - Portable Sawmill Layout

N. Brown and J. Bethel, Lumber, 2nd ed., pp23,33, John Wiley & Sons, New York, 1958

mechanized log turners since an experienced deckman with cant hooks can turn logs under 20 inches in diameter as quickly as can a power turner. In small permanent mills, log turners are sometimes used.

Power Log Loaders. The log loader and deck stop is designed, as the name implies, to perform two functions: (1) to hold the logs back on the sloping deck and prevent them from rolling onto the carriage while a log is being sawed, and (2) to load the log onto the carriage when the sawyer is ready for it.

A typical log loader and log stop is shown in Figure 12. This loader is used with a band saw that has teeth on each side of its band and cuts during forward and reverse carriage motion. The loader is positioned to pass the log to the carriage over the powered rollers. Lumber already cut passes under the arm while a log is being loaded. Two or three such load-stop arms are keyed to a shaft at intervals of four to eight feet. The shaft is attached to a deck beam parallel to the track.

Power Log Turners. Several types of log turners are commonly used to turn the log on the carriage. The logs are turned in a manner which will produce the maximum quantity of high-grade boards consistent with reasonable cost and market requirements. The sawyer decides how a log will be broken down; the success of a sawmilling operation frequently depends upon the soundness with which these decisions are made.

A hydraulic turner is shown in Figure 13. In A the log rolls onto the carriage due to the slope of the skids and the action of the loader. In B we see a second log being held back on the skids. In C the turner comes up and begins turning the log on the carriage. When the turn is completed, the turner holds the log against the "knees" as in D. Before sawing begins, "dogs" will secure the log on the carriage after which the turner will be restored to its original position.

Head Saw. The round log is reduced into smaller components such as beams or boards by the head saw. Several different types of headsaws are used, the most common being the single circular or band saw. A log placed on the carriage passes through the saw repeatedly until it is reduced to the desired components. After each cut the log is quickly examined by the sawyer to determine the saw placement which will produce the largest quantity of high grade lumber. The log may be turned many times during this breakdown process.

Carriage. The carriage is a vehicle used to transport the log past the stationary head saw. The carriage frame is constructed of either metal or wood and mounted on trucks which travel on a track. Small portable mills almost always use woodframed carriages.

Most carriages have blocks, knees, and dogs to secure the log during breakdown. A typical carriage is shown in Figure 14. This carriage has three horizontal blocks which mount on the carriage frame. Each block contains a rack which attaches to a vertical knee. A pinion engages each rack and is mounted on a shaft which runs through all the blocks. The knees can be moved with respect to the saw line by turning this shaft.

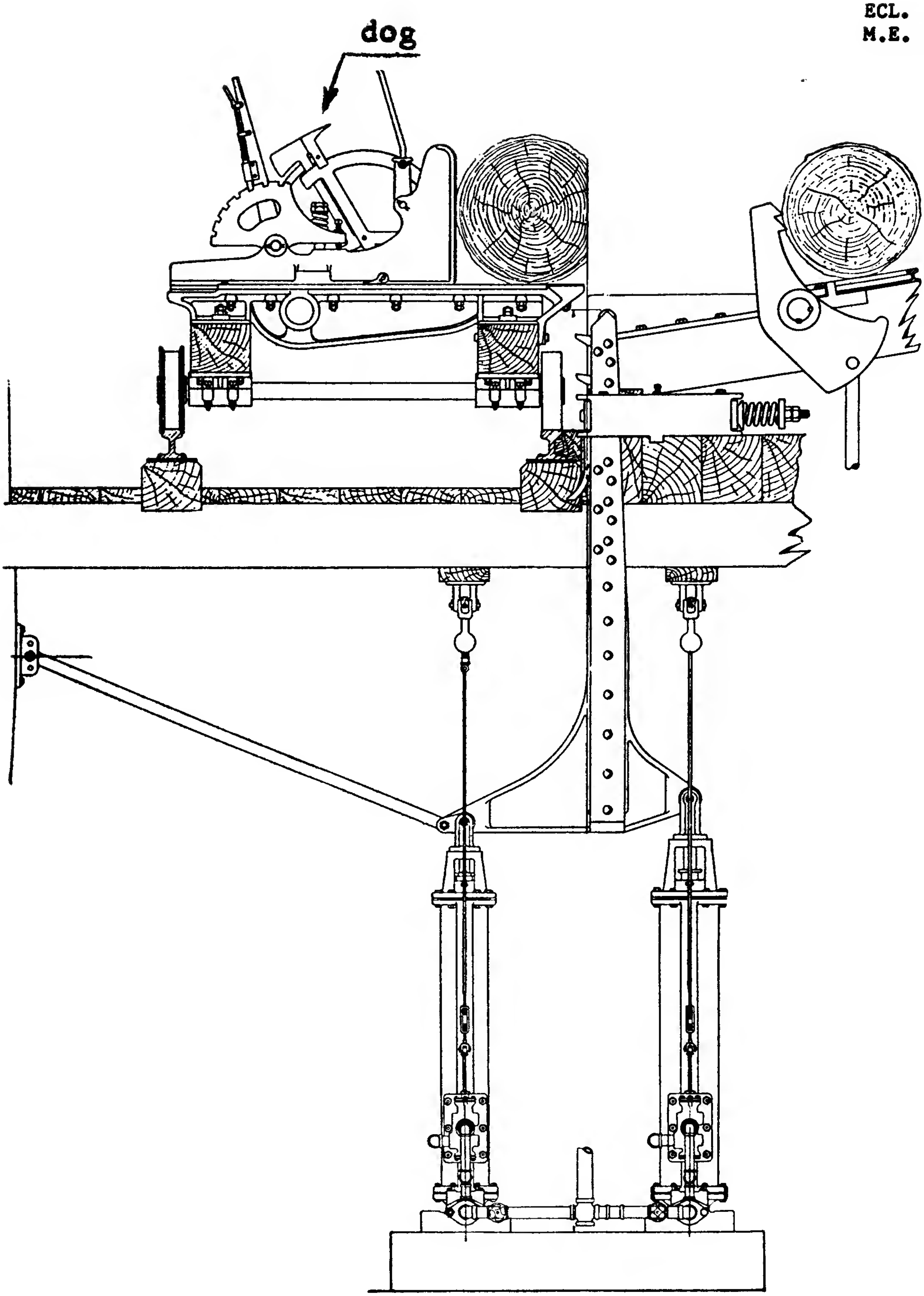


Figure 12 - Log Loader and Stop

N. Brown and J. Bethel, Lumber, 2nd ed., p61, John Wiley & Sons, Inc., New York, 1958

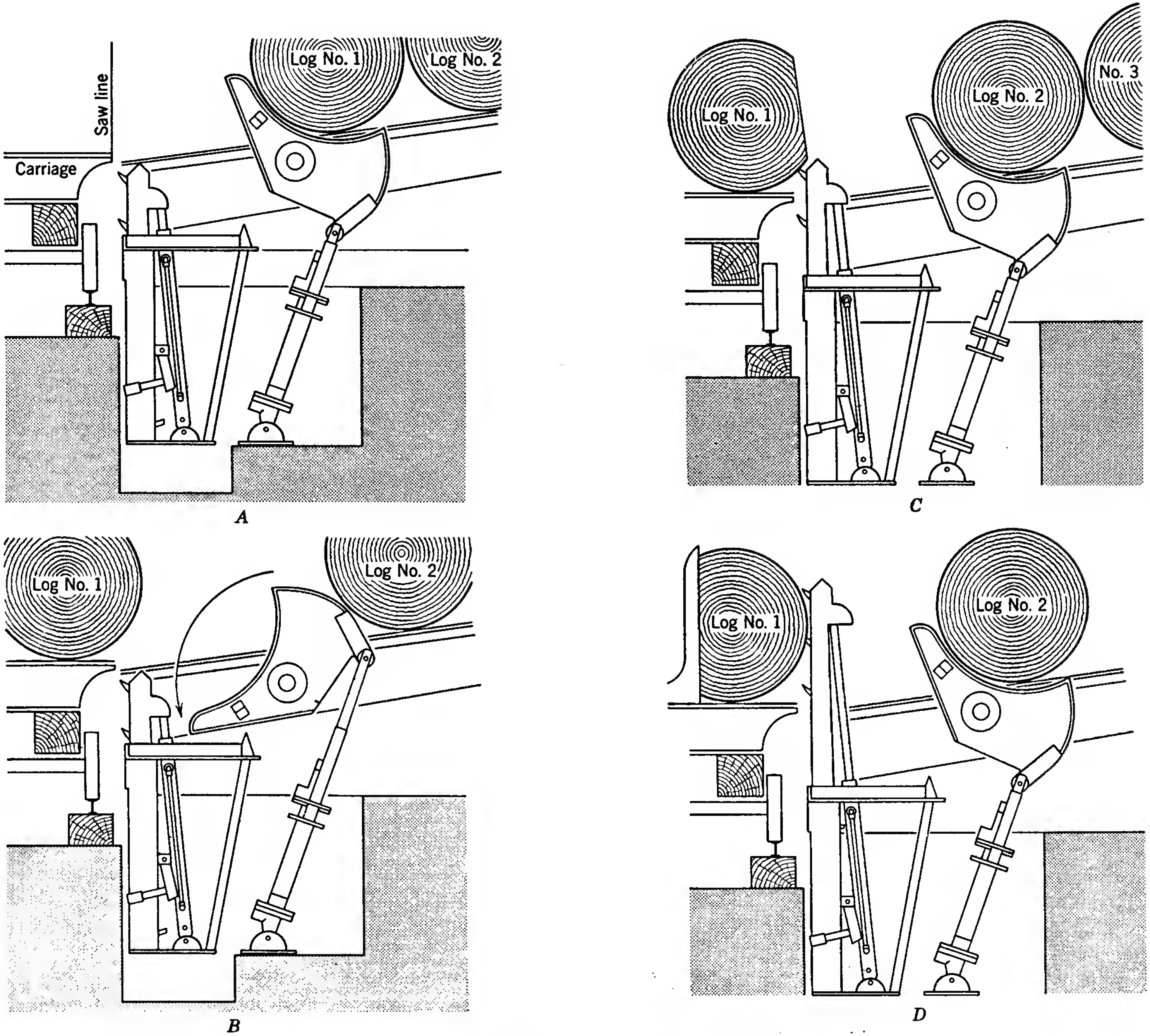
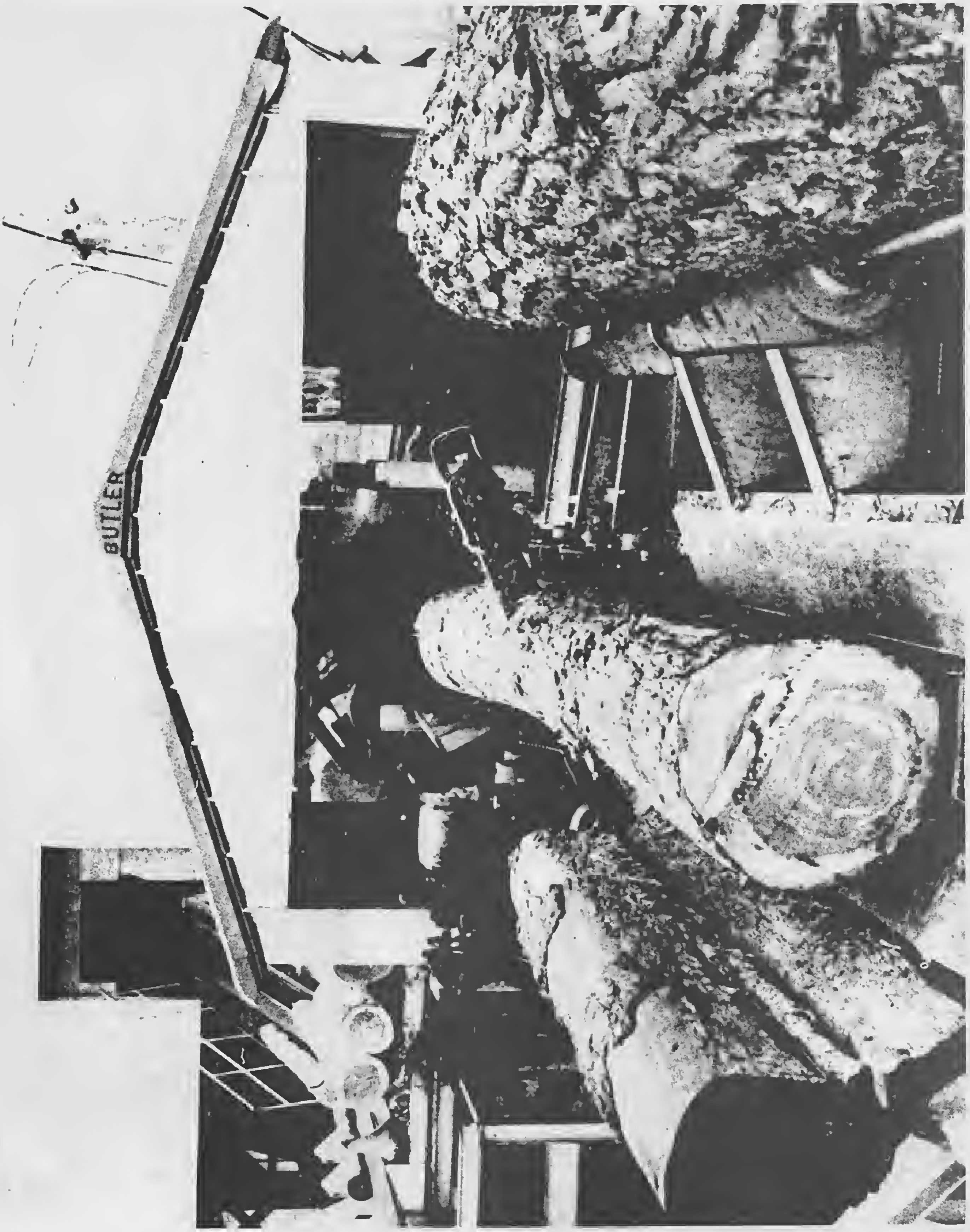


Figure 13 - Hydraulic Log Turner

N. Brown and J. Bethel, Lumber, 2nd ed., p62, John Wiley & Sons, Inc., New York, 1958

Figure 13 - Continued

Wide Drag Chain Log Haul
at Superior Studs, Inc.,
Newberry, Michigan



Hosmer Machine Company, Inc.
Contoocook, N. H.

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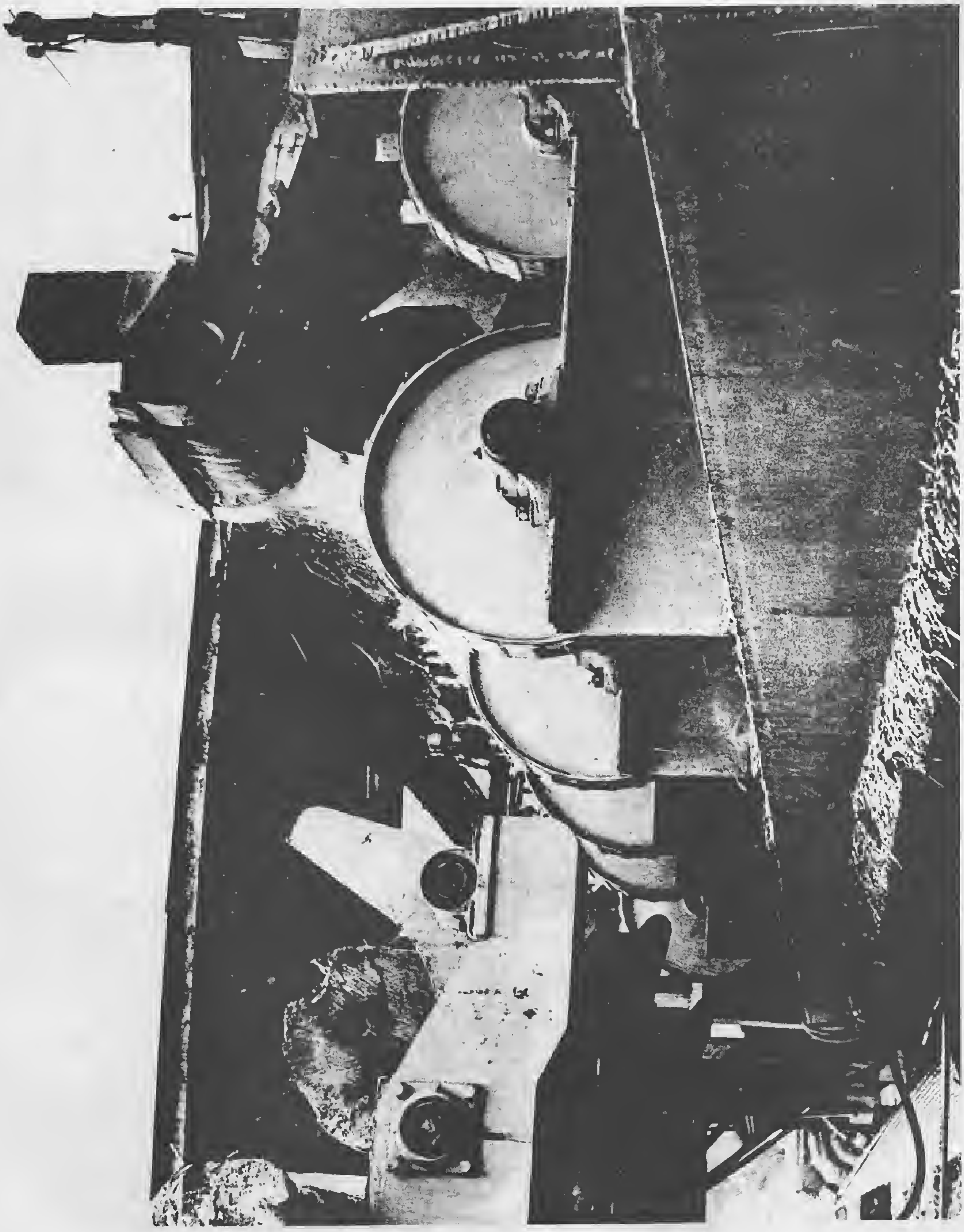
Figure 13 - Continued

Stop and Loader
at Taylor Lumber Company,
McDermott, Ohio



Hosmer Machine Company, Inc.
Contoocook, N. H.

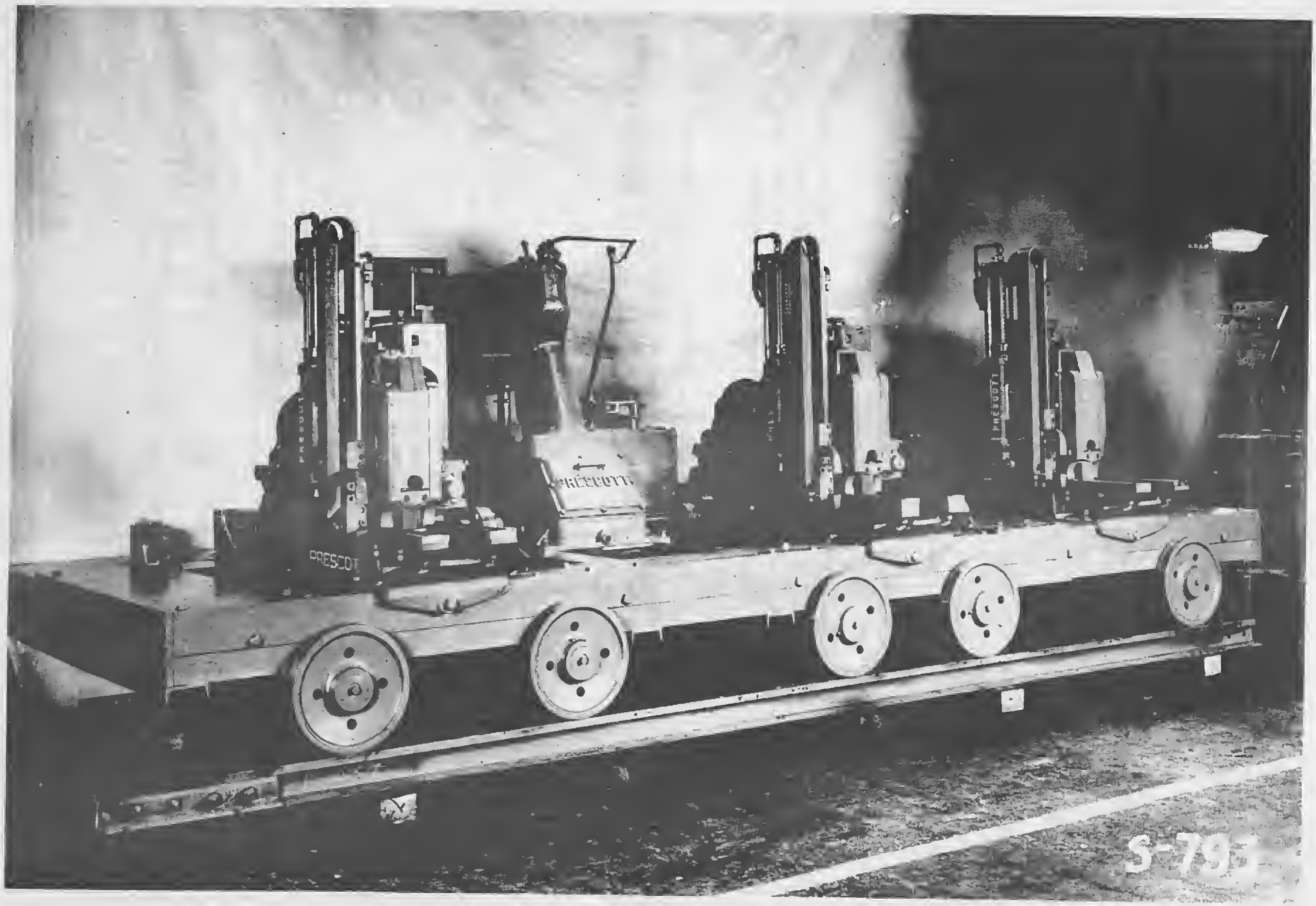


Figure 14 - Carriage

Courtesy of Prescott Co.

Pneumatically activated dogs are mounted on the knees and firmly hold the log or timber during cutting. After each pass of the carriage the knees and dogs are moved in conjunction with the log turner to reset the log for the next cut.

Edger. The edger functions primarily to produce lumber with parallel sides by removing the wane or rounded edges from the boards as they leave the head saw. Some secondary functions are the cutting of wide boards into smaller pieces of desired widths and the salvaging of valuable wood from knotty or otherwise low grade lumber.

Trimmer. Trimmer is a generic name which refers to a class of saws that (1) cut the ends of the boards square and parallel with each other; (2) cut the board into pieces of suitable commercial lengths; and (3) eliminate defects and render a board of more valuable grade. Trimmers vary widely in their operational capability. The simplest trimmer is a cutoff saw, but trimmers with several saws in large sawmills are usually able to perform all operations mentioned above.

Hog. A wood hog is a machine which converts sawmill waste, such as edgings, trimmings, and defective boards into small roughly-sized pieces which can be used for fuel. The hog contains a set of knives or hammers mounted on a rotating shaft within a heavy housing. As the knives pound against an anvil, the wood is reduced to small particles.

Surfacing and Shaping Equipment. Large sawmills are frequently equipped to surface and shape lumber. Modern surfacing machines produce furniture components and a variety of special moldings and dowels.

Selection of Circular Saws

Perhaps the most important historical development in the design of circular saws was the inserted tooth. This permits several sets of teeth to be used during the useful life of only one saw plate, thus reducing saw costs. Solid teeth are seldom used on head saws, although they are frequently used for edging and trimming. Inserted tooth saws use a plate made of steel, on the periphery of which sockets are punched or milled to secure the teeth and their holders, as illustrated by Figure 15. The sockets have a ridge which fits snugly into the holder and tooth. A hole is bored in the center of the plate to accommodate the mandrel or shaft. Head saws and edger saws normally have two additional lug holes bored on opposite sides of the center hole to fit a collar on the mandrel. Inserted teeth are swage set, i.e., they are flared at the cutting edge so that their cut is wider than the plate and necessary clearance is provided. Solid tooth saws may be swage set or spring set. Spring set teeth are bent away from the plane of the saw plate, adjacent teeth being set in opposite directions. A wide variety of tooth styles are available in both inserted and solid tooth saws. The selection of tooth style depends upon the kind of wood to be cut, the rim speed of the saw, and the rate at which wood is fed. Saw manufacturers can recommend tooth styles most appropriate to a specific application.

The amount of power required to drive a circular saw depends upon many factors. The most significant considerations are the width of cut, the number of teeth, the tooth pattern, the texture of the material being cut, and the rate at which lumber is fed into the saw. Specific values of these variables determine a minimum power requirement which sales representatives of saw manufacturers can calculate. In the absence of exact information reliable estimates of required driving power can be made based on past experience in sawmill design. Figure 16 gives an approximate relation between saw diameter and driving power for circular saws which are frequently used in small portable mills. Saws having an appropriate tooth pattern and thickness should perform satisfactorily when used with the driving power recommended in this graph.

Since there is an optimal sawing speed when cutting a particular texture of wood, it is desirable to provide some means for adjusting saw speed. Hanchett[1] recommends that the rim speed of inserted tooth saws not exceed 9000 f.p.m. Excessively high speeds may cause splitting or cracking.

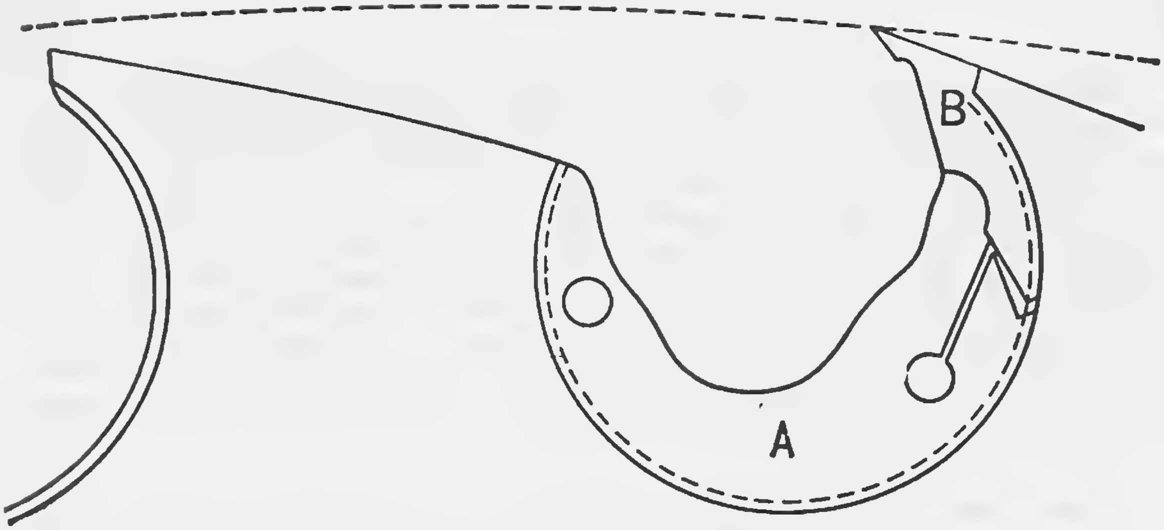
Band Saws

Band saws are commonly used as large head saws. The principle advantage of the band saw over the circular saw is that it cuts a narrower kerf, reducing amount of wood lost as sawdust. Statistically, logs cut with a band saw yield 5 to 7% more lumber than do logs cut with a circular saw.

During band saw operation, the tooth edge heats more than the back edge of the saw. Accordingly, the cutting edge expands more, and it is necessary to apply tension to the saw in a manner which assures proper shape during normal operation. Band saws usually run at speeds ranging from 6,000 to 12,000 lineal feet per minute. The higher speeds are appropriate for softwoods, the lower speeds for hardwoods.

Because of the narrower kerf and a more favorable cutting action, band saws require less driving power than a circular saw cutting at the same depth. Mr. J.A. Alich, President of Turner Machinery Corporation, has said "for a given depth of cut the driving power requirement of a band saw is approximately 1/2 that of a circular saw". Band saw feed rates range from zero to 400 f.p.m. Saw width is determined by the size of log being cut, the tooth design, and the guage of the band saw material. A 24-inch diameter log requires a band which is at least 1-1/2 inches wide and transported on a wheel whose diameter is no less than 24 inches. Preventive maintenance is a major cost of band sawmill operation. The mechanism transporting the band requires frequent and careful adjustment. It is a generally recognized fact in the sawmill industry that band saws require more sophisticated maintenance than do circular saws.

1. K.S. Hanchett, The Hanchett Saw and Knife Fitting Manual, Hanchett Manufacturing Company, Big Rapids, Michigan, 1950.



A Section of an Inserted-tooth Circular Saw Plate. *A*. Holder or Shank. *B*. Tooth.

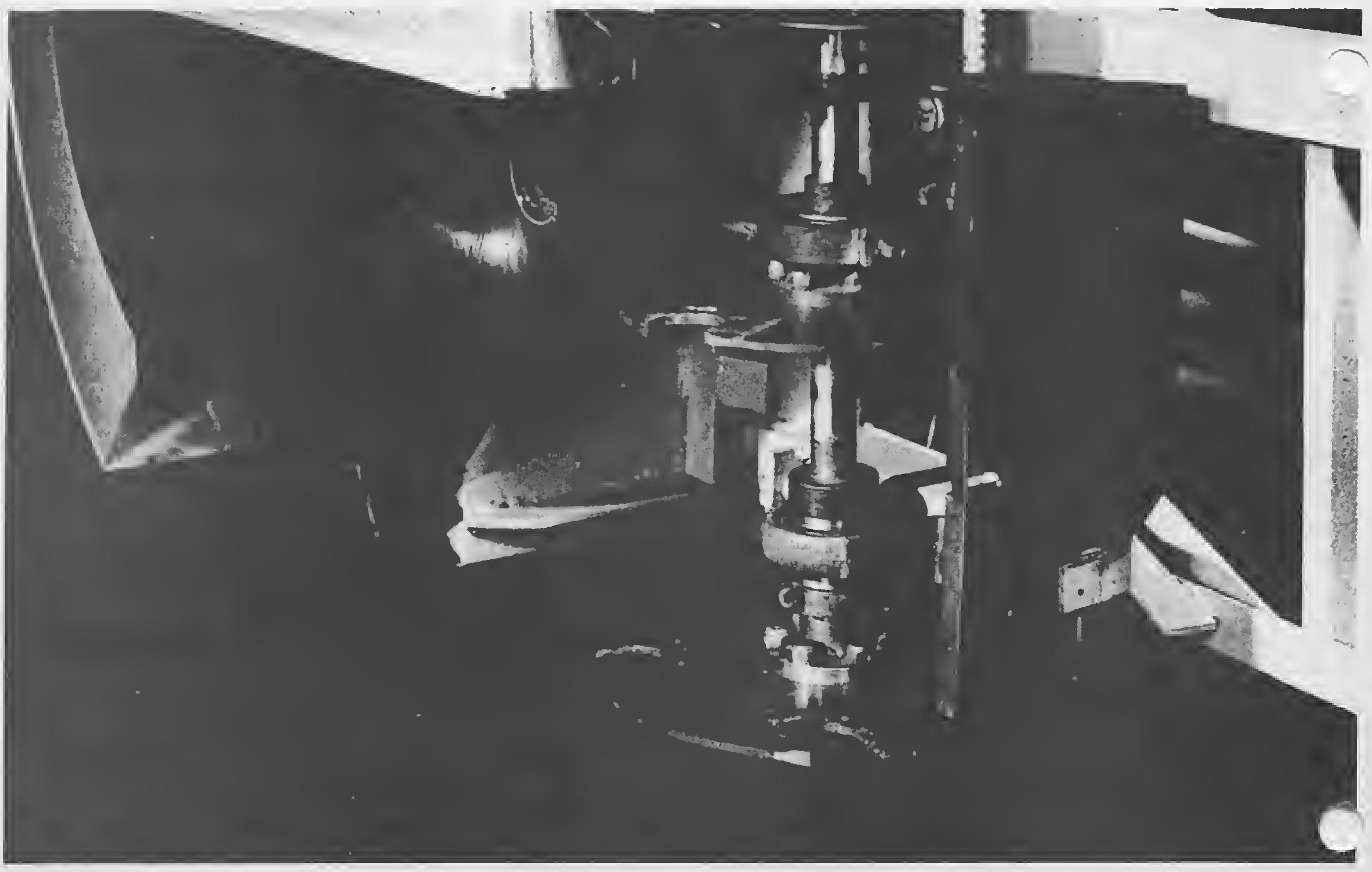


Figure 15 - Inserted Teeth

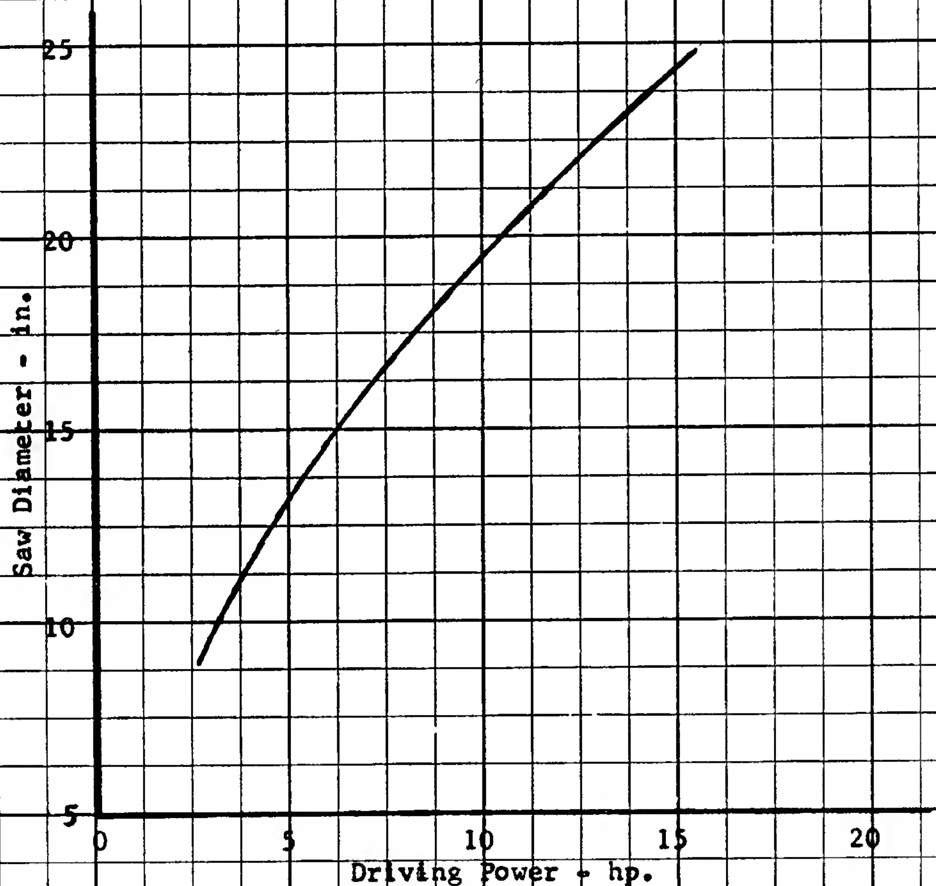


Figure 16

COMMON LUMBER REQUIREMENTS

Requirements for structural lumber are usually met by felling a tree in the forest and transporting it to a sawmill to be sawed into commercially usable sizes, grades, and finishes of lumber. Although it is desirable to convert the largest possible portion of the log into saleable lumber, some wood is lost as sawdust and low value wood fragments. Lumber is often surfaced and shaped to supply specific needs, and kilns are used to reduce moisture content to an acceptable level.

Frequently used sizes of structural lumber are commercially classified as being "rough" or "surfaced" according to the smoothness of their surfaces. Rough lumber is the product discharged from the edger and trimmer in a large sawmill and is the type usually produced by portable mills. Rough lumber is suitable and available for many commercial construction applications, as well as many non-commercial structural requirements such as sheds, barns, and fences. The dimensions of rough lumber are usually referred to in terms of "nominal" values; the table below indicates the most commonly used sizes. Common tolerances for rough lumber are ± 1/16 inch.

Item	Nominal Thickness, Inches	Nominal Width, Inches
Beams and Stringers	3 to 5	4 to 8
Joists and Planks	2 to 5	4 to 6
Posts and Timber	3 to 7	3 to 7

Lumber may be made more suitable for certain applications by smoothing the surface to yield finished or surfaced lumber. Surfacing is typically done by a planer or jointer. Surfaced lumber is usually classified by nominal dimension. Consequently, the actual size of a surfaced board will be smaller than its nominal size. Lumber produced by a portable mill is often hauled to a large sawmill which specializes in surfacing.

SMALL PORTABLE SAWMILLS

The TIMBER CHAMP

The H.H.C. Research and Development Corporation of Portland, Oregon manufactures and sells a small portable sawmill called the TIMBER CHAMP. The TIMBER CHAMP is a portable one-man precision saw capable of being moved to any site where trees have been felled. If the trees are large, the TIMBER CHAMP attaches directly to the log to produce straight boards. Small logs are sawed in turn after ganging them on a simple deck. These procedures are illustrated in Figure 3. One man can set up the TIMBER CHAMP and subsequently produce up to 8000 board feet per day. Assembly is simple and operation is not difficult. The saw can produce lumber with a maximum length of 17 feet, and a maximum width and thickness of 8-1/4 and 2-1/4 inches, respectively.

The TIMBER CHAMP has a 22-inch arbor saw, which accomplishes the major breakdown of the log, and two edger saws which edge lumber to the desired dimension. An 18 horsepower four-cycle engine supplies driving power to

all saws. The engine and saws are moved under power along a rigid track placed beside the stationary log. Figure 3 shows the general layout of the main sawing assembly, and some specifications are given below.

TIMBER CHAMP SPECIFICATIONS

Weight: 447 pounds
Track Weight: 100 lbs. per section
Carriage: 100 lbs.
Engine: 147 lbs.
Job Rated: 3,000-5,000 B.F. per day
Fuel Consumption: 1 gallon per hour
Maximum cut: 2-1/4" x 8-1/4"
Minimum cut: Veneer x 2"
Cutting Cycle: 65-75 seconds
Saw Kerf: 9/32"

Main arbor saw: 22" diameter
Top Edger saw: 8-1/2" diameter
Bottom Edger saw: 8" diameter
Standard track length: 20 feet
(additional lengths to special order)
Engine: OMC, 18 h.p., 2-cylinder 4-cycle air-cooled rope or electric starter Cylinder head integral with Cylinder
Retail cost: $2,950 F.O.B. Portland, Oregon

The ALASKAN

An accessory compatible with most commercially available chain saws is the ALASKAN. The ALASKAN is manufactured by Nygran Industries of Richmond, California, and equips most chain saws for the production of full-sized, accurately cut lumber without moving the log from its felled position. The general features of its operation are illustrated in Figure 4.

Calibrated risers allow cuts of any thickness from 1/2 inch to 18 inches and widths up to four feet are possible. A strong 2 inch by 12 inch log is initially cut. No special tools or extensive alterations to the chain saw are required. The only necessary modification is the drilling of three 3/8 inch holes in the saw bar. The ALASKAN is operated in conjunction with one or two identical chain saws which employ either direct or gear drive. Proper operation is possible if total saw power ranges from 6 to 8 horsepower.

Cut lumber production yields are influenced by the type and size of lumber being cut, dimensions of lumber desired, number and total horsepower of saws used, type of chain, quality of sharpening, and similar considerations. Estimates of relative cutting speeds for various drives and sizes of power units are given below. Since the conditions existing at a particular operation may vary, these figures should not be used to accurately compute total output. The ALASKAN is available with the horizontal roller widths of 16 inches to 50 inches; the corresponding weights are 31 lbs. and 43 lbs. respectively. Retail prices of the ALASKAN range approximately from $160 to $215.

Lumber Size	No. of Saws	HP	Drive	Cutting Time
2" x 12" x 16'	2	9	Gear	1-1/2 minutes
2" x 12" x 16'	1	9	Gear	4 minutes
2" x 12" x 16'	2	7	Gear	1-1/2 minutes
2" x 12" x 16'	1	7	Gear	4 minutes
2" x 12" x 16'	2	6	Direct	4 minutes
2" x 12" x 16'	1	6	Direct	7 minutes

COMMENTS OF SAWMILL MACHINERY DESIGNERS

In September, 1964, a casewriter visited the Hosmer Machine Company (HMC) of Contoocook, New Hampshire. LaRue Hosmer, vice president and general manager, described the company as one of the three largest sawmill machinery manufacturers east of the Mississippi. Employing about 30 people, it offered a full line of equipment, including log debarkers, saw carriages, and conveyers manufactured in its own shop, plus a number of complementary machines manufactured by other companies. Mr. Hosmer commented that the greatest number of sawmill machinery makers operated very small "garage like" shops and built machines one at a time, often without blueprints. As the larger companies improved their designs and production methods through better organization, he expected most of the small shops would be driven out of competition, possibly within the next ten years.

Mr. Hosmer personally had done much of the design and testing work on early products made by the HMC during the mid 1950's. Thereafter, an engineering department had been organized, and he had devoted his time mainly to sales, production, and general management. Recalling his experiences, particularly in sales, Mr. Hosmer expressed three caveats for the designer of sawmill equipment.

> "First, I would remember that every log is different. Logs vary widely not only in size and wood properties such as hardness, but also in shape. There may be all sizes of branches, stubs of branches, knots and rotten spots, and the logs themselves may be crooked. If the logs have been moved around on the ground, there may also be rocks and other debris imbedded in the bark.
>
> "Second, logs are heavy. This means that if it is possible to bust a piece of machinery, it'll be busted in a sawmill. Our first log debarker was built using 2-7/16 inch steel shafting for log rollers with bearings at four foot intervals. Those shafts failed from fatigue after as little as 1600 hours of operation. Now we use 3-7/16 inch diameter shafts (C1141 high carbon steel, ground and polished).
>
> "Third, do not expect workers in a sawmill to be careful. I've seen men with only three fingers left unnecessarily pushing them to within three inches of a screaming saw with the safety guards removed for greater convenience.
>
> "Working in a sawmill is low paying, hard and monotonous, hence does not attract a high proportion of highly motivated and bright people. If a left-hand thread were used in a machine, I'm afraid most of them would never puzzle it out."

The chief engineer of the Hosmer Machine Company was Mr. Charles Crathern. Upon graduating in 1952 as a mechanical engineer from the Worcester Polytechnic Institute in Massachusetts, he had first spent two years with a manufacturer of

heavy machinery for paper mills. Most of this time had been spent rotating through various apprentice type jobs in the shop as part of the company's training program. "I didn't particularly enjoy it at the time," he recalled, "but it paid off. It's one thing to know what can be done theoretically and another to have to build the machine. Working in the shops gave me some appreciation of the problems of those who have to build an engineer's designs."

He next worked for a manufacturer of automatic machinery for making small boxes, such as candy boxes. "That work differed from my earlier experience in some ways," he said. "The packaging machinery was lighter and involved the precise interaction of a greater number of complex mechanisms. Also, having more experience, I did more designing. I think I developed a greater appreciation for customers' problems of operating and maintaining the equipment, since many of the machines were custom-designed for individual situations. I also learned the value of a thick skin. It's easy to criticize, so lots of people do it."

In 1961, Mr. Crathern accepted an offer to join the Hosmer Machine Company. His comments on problems of designing sawmill machinery were as follows:

> "It's hard to foresee the strength requirements in this sort of equipment. Just knowing the weight of a typical log doesn't really help much. Somebody can always find a heavier one or else a way to drop one farther. Right after college I probably would have tried to measure forces and do some stress analysis on all machines, but now I don't.
>
> "Characteristics of the logs themselves are hard to predict. You can't expect them to be straight or cylindrical. They come in different degrees of hardness, and they may be frozen solid in the winter.
>
> "With these rugged performance requirements it would be nice to be able to impose conditions of careful maintenance on the machinery, but that is impossible. In most sawmills the only tools you can find are crowbars, sledgehammers, and maybe an adjustable wrench lying around somewhere among a bunch of dull files.
>
> "Most sawmills are small operations, and because of intense competition sawmill operators hate to spend any time on maintenance or stopping for repairs. They have to keep those logs coming out to survive. A machine will be run until it quits. Then some temporary repairs will be made to carry it through the rest of the day, and it will be forgotten until it breaks again. Consequently, in a sawmill you find all sorts of cobbled up repairs: baling wire, parts shaking loose, four groove sheaves with only two belts on them and those belts loose, and so forth.
>
> "Low cost is another important factor to the small mills. Most of them are always close to broke and many of them do fail. If your machinery costs more than they think they would pay by making their own, they won't buy one from you. So we have to work for economy, although this is something many engineers hate to do."